UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
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August 18, 2020

Colonel David R. Hibner
U.S. Army Corps of Engineers, Alaska District Regulatory
Division P.O. Box 6898
JBER, Alaska 99506-0898

Re: Pebble Mine Project, POA-2017-271

Dear Colonel Hibner,

The National Marine Fisheries Service (NMFS) has reviewed the United States Army Corps of Engineers' (USACE) Essential Fish Habitat (EFH) Assessment and updated Project Description for the proposed Pebble Project received on June 19, 2020. Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NMFS on all actions that may adversely affect EFH.[1] NMFS is required to make EFH Conservation Recommendations, which may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects.

In this letter, we review each major component of the proposed Pebble Project and provide EFH Conservation Recommendations to minimize adverse effects to EFH. Our EFH Conservation Recommendations should be considered in addition to the mitigation measures identified in the EFH Assessment. Our review and recommendations build on our involvement in reviewing this project and providing recommendations designed to understand and reduce impacts to EFH since 2004 (see Enclosures). In 2019, we reviewed and provided comments on the Draft Environmental Impact Statement (DEIS) and Draft EFH Assessment.

NMFS remains concerned that the proposed Pebble Project has the potential to have substantial adverse effects on salmon EFH in the vicinity of the mine site and downstream areas. Substantial adverse effects pose a relatively serious threat to EFH that cannot be alleviated through modifications to a proposed action. As discussed in detail below, the proposed mine activities would fundamentally change the freshwater habitat in the vicinity of the mine and downstream areas. These changes would result in a decrease in water volumes, habitat complexity, and water quality, and, coupled with decreasing forage opportunities and increasing water temperature, would combine to decrease available salmon EFH. These adverse impacts to salmon EFH are either not possible to mitigate or the success of mitigation is highly uncertain for a project of this magnitude that is attempting to manage tremendous volumes of water and waste.

[1] As recognized in the EFH Assessment, Essential Fish Habitat (EFH) are "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate (50 CFR 600.10). The level of detail in an EFH Assessment "should be commensurate with the complexity and magnitude of the potential adverse effects of the action" (50 CFR 600.920(e)(2).

These concerns and uncertainties apply to the proposed Pebble Project footprint and 20-year time horizon identified in the current Project Description, and would also significantly increase should the project be expanded in the future.

In reaching this conclusion, we considered the following:

- Freshwater river systems and lakes are EFH for all species of salmon within the project area and in the Bristol Bay watershed.
- The most important EFH attribute supporting the abundance of salmon within, surrounding, and downstream of the mine site are the aquatic ecosystem processes and abundant surface and groundwater regimes that currently exist in a natural pristine condition.
- Based on the experience from other large mines, we expect the proposed Pebble Project to alter watersheds and water quantity and quality, which directly affects salmon survivability. These impacts would continue to occur for an undefined and highly variable distance downstream.
- Impacts from the majority of the mine's earthworks, excavations, and infrastructure will be permanent.
- The mining action would likely expand over time and extend beyond the initially defined footprint. Expanding excavations and increasing porphyry metal processing dictate increasing water withdrawals, water treatment, and water management and release in the future with the effects to ecosystem function extending in perpetuity.

Finally, we would like to highlight that the Project Description and EFH Assessment have not fully described some project components that have the potential to substantially adversely impact salmon EFH. These include, but are not limited to, details of the water management plans that are needed to manage surface and groundwater in perpetuity, and the methods and technologies that will be used to treat the anticipated volumes of waters containing the anticipated mine wastes. Lacking this more detailed discussion adds to the uncertainty regarding whether the proposed plans would be sufficient to effectively manage and treat water and mitigate adverse impacts to water quality, over the life of the mine and after the mine closes.

1. Project Description and Project Area

According to the Project Description, the Pebble Limited Partnership (PLP) proposes to develop and operate an open-pit mine and porphyry ore processing facilities to produce copper, gold, molybdenum, and other commodities. As currently proposed, the mine would operate for 20 years, excavating a pit 6,800 feet long, 5,600 feet wide, and 1,950 feet deep. Development of this prospect would include construction and maintenance of multiple facilities to store pyritic and bulk tailings, and potentially acid-generating and metal-leaching materials. The project site would also contain multiple sediment and seepage collection ponds and materials quarries. Additional infrastructure components include the construction of an 82-mile transportation corridor connecting the mine site to a port facility with a two lane road, fiber optic cable, multiple pipelines supporting natural gas, metal concentrate slurry, and mine contact water transfer. The natural gas pipeline and fiber optic cable would run from the port facility across

Ursus Head to Ursus Cove and continue across Cook Inlet to the Kenai Peninsula. The newly constructed port facility will support shipping for extensive equipment, materials, and manpower supply chains, including an offshore lightering operation in Iniskin Bay, Cook Inlet. Additionally, power generation facilities would be constructed at the mine and port facilities. Many of these project components involve work in and discharge of fill into wetlands and waters of the United States.

As identified in the EFH Assessment, the proposed Pebble Project is located within two watersheds, Bristol Bay and Cook Inlet. The proposed mine site spans headwaters of the Nushagak River and Kvichak River, and the transportation corridor crosses tributaries that flow into Lake Iliamna, all of which flow into Bristol Bay. The port and natural gas pipeline would be located in Cook Inlet.

2. Essential Fish Habitat as Defined in the Fishery Management Plans

The EFH Assessment analyzes impacts to EFH for species managed under the Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska (Salmon FMP), the Fishery Management Plan for Groundfish of the Gulf of Alaska (GOA Groundfish FMP), and the Fishery Management Plan for the Scallop Fishery off Alaska (Scallop FMP). EFH is designated for these species life stages based on Level 1 (distribution) and Level 2 (habitat-related densities) information. The North Pacific Fishery Management Council and NMFS do not designate EFH for forage fish and other ecosystem component species included in the GOA Groundfish FMP, however forage fish are prey resources for several managed species and are thus considered an important EFH attribute.

The EFH Assessment provides a description of many of the anticipated impacts to EFH and provides mitigation measures intended to measurably reduce short-term and long-term impacts to EFH. However, the Project Description and EFH Assessment have vague descriptions of some project components that have the potential to substantially adversely impact EFH. In the discussion below, we use the best available information to assess these components and provide EFH Conservation Recommendations, recognizing that it is not possible to know exactly what will be built at this time and therefore the EFH Conservation Recommendations should be considered in developing detailed project plans.

3. Potential Impacts to Freshwater Salmon EFH

Under the Salmon FMP, EFH is designated for salmon in the freshwater river systems and lakes within the project area. The mine site and transportation corridor would impact freshwater salmon EFH in the Bristol Bay watershed.

The most important EFH attribute supporting the abundance of salmon within, surrounding, and downstream of the mine site are large volumes of nearly pristine water (Bogan et al. 2018; Zamzow 2018). Gravity moves groundwater down gradient through porous saturated substrate to eventually express in surface waters downstream (Bilby and Naimen 1998; Younger 2009; Poehles and Smith 2011). Evidence suggests many adult salmon prefer to build redds, spawn and deposit eggs on and near upwelling water sources (Geist 2000; Malcolm et al. 2003 and 2005).

Such groundwater influenced upwelling supports egg survival in freezing winter conditions (Cunjak and Power 1986; Cunjak 1996). These interactions between ground and surface waters support aquatic communities through temperature regulation (Boulton 1993; Boulton et al. 1998; Boulton and Hancock 2006). The abundance of water supports connectivity to numerous secondary, still water side channels and eddies where salmon fry and parr seek refuge and grow (Mason and Chapman 1965; Woody and O'Neal 2010).

As keystone species, Bristol Bay salmon transport significant amounts of nutrients to and from terrestrial watersheds and the eastern Bering Sea (Limpinsel and McConnaughey 2018). The Ecosystem Modeling Team at the NMFS Alaska Fisheries Science Center evaluated the contribution of Nushagak River and Kvichak River sockeye salmon to trophic dynamics in the eastern Bering Sea and North Pacific ecosystems and concluded "*salmon from these rivers rank among the top ten forage groups, comparable to Pacific herring or eulachon as a nutritional source for other marine species*" (Gaichas and Aydin 2010).

Natural resource extraction projects of this nature have the potential to induce different degrees of impacts on EFH depending on the nature, scale and scope of the project and surrounding ecosystem processes (Younger et al. 2002; Lottermoser 2010). Specific to any project, with respect to salmon EFH, we first consider the presence and abundance of water and salmon, then consider impacts in terms of duration (short or long term, temporary or permanent), with focus on aquatic ecosystem processes such as water quality that support EFH. Considering these factors, we also assess whether impacted ecosystems will recover after the disturbance; or whether the impacts of the action continue to degrade ecosystem function in a continual cumulative or synergistic manner.

3.1 Salmon Distribution and Abundance

The EFH Assessment underestimates the value and function of different types of habitat, the supporting aquatic processes, and the numbers of salmon, especially juveniles, affected by the proposed Pebble Project. As salmon migrate upstream, their numbers become fewer. However, the number of salmon in a given stream reach is highly variable among species, run timing, life stages, environmental influences, and over seasonal and annual temporal scales (Schindler et al. 2010). For example, juvenile coho salmon will voluntarily move 1,148 to 4,265 feet (350–1,300m) in a day based on prey availability and water temperature (Armstrong 2013).

The studies conducted to inform the EFH Assessment did not consider this variability in designing the fish surveys or in determining the distribution and abundance of salmon that would be impacted by the project. Conducting fish surveys using consistent methods to inform statistical analysis and provide defensible conclusions on salmon distribution and abundance is important to understand impacts to habitat and develop appropriate mitigation measures (Gunderson 1993; Cochran 2007; Johnson et al. 2007). We have provided detailed comments over the years on ways to improve study designs to more accurately and defensibly document the distribution and abundance of salmon in the project area (see Enclosures).

3.2 Mine Site

The DEIS describes the approximate acreage and linear stream miles permanently lost to the mine footprint and surrounding infrastructure. The EFH Assessment estimates that 8.5 miles of EFH would be permanently removed from mine site development and asserts that stream reaches and habitat lost within the footprint of the mine or under the influence of mine-altered water regimes are poor quality habitat, of little importance, and support low numbers of salmon. Subsequently, the EFH Assessment concludes that the loss of habitat and associated salmon pose little impact in relation to the overall salmon populations in the watersheds. As explained in detail below, we disagree with these conclusions. We are concerned that the proposed plans for removing, treating, and reintroducing water remain experimental at best, and how early life stages of salmon will respond to significantly altered freshwater habitat over time is highly uncertain.

The EFH Assessment does not provide a detailed analysis of direct and indirect impacts to salmon EFH associated with removing and altering the surface and groundwater regimes underneath and downstream of the mine site, and changing water quality throughout the watershed. While the updated Project Description does provide additional description of the mine site, mineral processing, and water treatment, neither provide a detailed analysis commensurate to the potential impacts to water, the key EFH attribute.

The Federal regulations implementing EFH requirements state that the level of detail in the EFH Assessment should be commensurate with the potential adverse effects of the action (50 CFR 600.920(e)(2)). To identify and understand the impacts to EFH, the EFH Assessment should provide more detail on (1) the methods and assumptions used in the water management models to develop the water management plans, (2) the complete removals and disruption of the ground and surface water regimes and the distance downstream where natural water regimes would resume, (3) the water storage and treatment processes, (4) the plans to reintroduce treated water back into the system, and (5) the impacts of these changes to the ground and surface water regime to the entire watershed.

3.2.1 Water Management

We appreciate the conceptual water management plans and descriptions of water management models. However, given the complexity and interaction of these surface and groundwater regimes and the project's need to manage water in perpetuity, we assume the project proponent has more detailed analysis of the model designs and assumptions, the data used to inform the model, the methods of analysis, and the model conclusions than what is presented in the EFH Assessment. Without this more detailed discussion of the water management models, it is uncertain whether the proposed water management plans would be sufficient to effectively manage mine contact water, over the life of the mine, and after the mine closes.

The EFH Assessment does not explain how the water management plans account for the fact that the climate is changing. Water management plans must be designed to accommodate the projected changes in climate in this region, including the increasing levels of precipitation, with more frequent winter rain and less snow, and more intense storms.

The abundant and nearly pristine ground and surface water regimes in the project area produce ideal conditions to support salmon populations. To the contrary, this abundance of water is challenging to manage in mining porphyry mineral deposits. We remain concerned about the continued need to manage increasingly larger volumes of water and waste, specifically; (1) the continued gradual lowering of the water table outside the pit excavation as it expands, (2) the continual increase in volumes of mine contact water to be managed, stored, treated, and discharged, and (3) during post mine closure, the inevitable need to manage and release in perpetuity large volumes of mine contact water when surrounding ground waters re-establish equilibrium and resume outflow. These actions increase the cumulative and synergistic effects on downstream habitat quality and salmon survival. We discuss each of these elements of water management below.

3.2.2 Water Removal at the Mine Site

To excavate the mine pit to the eventual dimensions projected to provide access to the mineral deposits below, a significant volume of groundwater needs to be completely removed. Using more than 50 dewatering wells to remove millions of gallons of water from the ground will alter ground and surface water flows, changing the existing hydrology for an unknown distance surrounding the mine. The groundwater and associated aquatic processes in the mine footprint would be completely removed by excavating the mine pit or buried by tailings impoundments or water storage ponds. The water quality and quantity, and aquatic processes surrounding the mine would also be significantly altered. The extent of the surrounding area and the severity of impacts remain undefined and are highly variable over time and distance from the mine footprint. Furthermore, as the pit excavation gradually expands, it becomes increasingly necessary to remove more water from the ground, decreasing available surface waters, and further increasing the dewatered area as the cone(s) of depression expand. Water quality and quantity, and aquatic processes would resume naturally downstream, though this distance remains unknown and highly variable.

Removing the projected large volumes of water from the mine site and surrounding area would alter salmon spawning and rearing habitat. Decreasing water volumes alters temperature, dissolved oxygen, and forage opportunities. Salmon depend on water availability in small tributaries during crucial time periods for spawning and juvenile rearing. The severity of the effects of these physical changes are highly variable depending on the species and life stage of the salmon, though overtime all likely diminish habitat quality and salmon survival. The impacts of water removal and water degradation to salmon are well represented in the literature (Baldwin et al. 2003 and 2011; Montgomery 2003; Hughes et al. 2006; Di Giulio and Hinton 2008; McClure et al. 2008; McIntyre et al. 2008).

3.2.3 Water Storage and Treatment at the Mine Site

We are concerned that the water storage and treatment processes narrated in the Project Description are not well described and may not be effective in treating large volumes of mine contact water in perpetuity. The lack of technical details provide little assurance that methods proposed would be successful at this scale, in a watershed of this hydraulic complexity supporting large populations of salmon. Mining operations that process higher quality ores in

regions with less precipitation and lower volumes of ground and surface water interaction, often exceed predicted and permitted discharges of mine contact water (Younger 2003; Kuipers et al. 2005; Maest et al. 2005; Castendyk and Eary 2009; EPA 2018). Exceedances in metals or total dissolved solids often result from (1) error or uncertainty in the modeling used to predict metal precipitates removed versus metal precipitates remaining in solution and expelled, (2) water treatment systems that are overwhelmed by unpredicted volumes of water, (3) inadequately engineered or installed equipment for unpredicted or unanticipated water scenarios, and (4) mitigation measures and facility designs that do not perform as anticipated. We suggest more analysis of the methods and technologies proposed to treat the anticipated volumes of waters containing the anticipated mine wastes and their proven effectiveness in subarctic environments. This would provide a better understanding of the effectiveness of the water treatment plans and the impacts on water quality in salmon streams.

We are also concerned about the possible failure of tailings embankments made to contain the pyritic tailings, bulk tailings, and water management ponds. If any of the six proposed embankments catastrophically fail, EFH would be damaged for an unknown distance downstream and water quality could be negatively affected for miles. A recent example was seen in Brazil in 2015 (Queiroz et al. 2018). The Samarco tailings dam collapse released 50 million cubic meters of mine tailings into the Rio Doce. Mine tailings and waste water traveled 650 km (403.89 miles) of the Rio Doce watershed arriving in the marine estuary 17 days later. Bristol Bay is approximately 209 river miles from the mine site. Several other similar incidents are described globally in different reviews (Armstrong et al. 2019a and 2019b; Lyu et al. 2019). The influence of seasonally repeated freezing and thawing of water seepage and drainage under earthen structures should also be evaluated in the impoundment design and possible response scenarios (Doroshenko and Nevzorov 2016).

Even if mine wastes and mine contact water appear contained, potentially acid generating or metal leaching rock contact water can infiltrate groundwater in these drainages and resurface as water harmful to salmon (Younger et al. 2002; Lottermoser 2010). A recent study unequivocally demonstrates the movement of pollutants in tracers from terrestrial sources through the ground to marine waters (Glenn et al. 2013).

Low concentrations of metals have been shown to have detrimental impacts to salmon (Lundebye et al. 1999; Baldwin et al. 2003 and 2011; McIntyre et al. 2008). Heavy metals are widely recognized to persist in the environment, becoming bioavailable and bio-accumulating through freshwater and marine organisms where they magnify in concentration as they move through food chains (Di Giulio and Hinton 2008). Metals and mine contact water adversely affect salmon survival and growth to maturity, and can interrupt migrations. Similar negative responses are observed in many different fish species (Di Giulio and Hinton 2008). It remains highly uncertain how different species and life stages of salmon would adapt to the changes in ground and surface water quality resulting from the mine and the extent water quality will be changed downstream. We provide EFH Conservation Recommendation below to minimize adverse impacts from mine contact water.

3.2.4 Reintroducing Treated Mine Contact Water

The EFH Assessment briefly suggests a method to mitigate the impacts of dewatering the groundwater aquifers, by reintroducing treated mine contact water to the remaining tributaries somewhere outside the mine footprint to maintain instream flows. Overall, tributaries receiving water will change from natural upwelling groundwater fed systems to systems fed treated mine contact water. Though models were used to predict and recreate instream flow velocities in main stem channels, the analysis does not indicate side channel rearing habitat or other important habitat attributes were included in the analysis (e.g. groundwater upwelling, temperature, dissolved oxygen, and nutrition). More advanced models are being developed in an attempt to represent these important EFH attributes (Wheaton et al. 2017).

As previously provided in comments (JASR 2009; NMFS-CM 2019), there are several EFH attributes that need to be considered in analyzing, monitoring, and recreating or restoring aquatic processes in salmon watersheds; (1) upwelling groundwater sources that support the survival of overwintering salmon embryos in hyporheic gravel substrates, (2) slow water eddies and side channels that are important habitat for juvenile salmon (fry and parr), rearing and resting from higher velocity water, (3) relatively consistent cold water temperatures and adequate dissolved oxygen that are crucial for early life stages of salmon, (4) environmental conditions that promote feeding and forage opportunity, and (5) upwelling groundwater where adult salmon que in on to spawn and deposit eggs.

We remain concerned that the EFH Assessment and proposed mitigation measures overlook many of these EFH attributes when reintroducing mine contact water to maintain instream flows. Additionally, we are aware and remain concerned that PLP's water rights reservations, filed in 2006, suggest decreases in water volumes several miles downstream of the mine site (ADNR 2006 and 2019; EBS 2019). Seasonally altering water volumes, temperatures, levels of dissolved oxygen, and forage opportunities all decrease the probability of salmon survival. It also remains highly uncertain how each species at different life stages will respond to these changes and the distance these changes will extend downstream. Reintroducing treated mine contact water to any remaining surface waters downstream without accounting for these EFH attributes increases uncertainty and impact severity. We provide EFH Conservation Recommendations below to minimize impacts of reintroducing mine contact water.

3.3 Transportation Corridor

The proposed transportation corridor would extend 82 miles from the port at Diamond Point to the mine site along the north shore of Lake Iliamna. The corridor consists of the road and bridges, and three different pipelines; a natural gas pipeline, a pipeline carrying concentrate slurry to the port, and a return water pipeline to carry mine contact water back to the mine site.

As described in the Project Description, all pipelines would be buried adjacent to the access road and attached to 11 bridge structures that transect larger river crossings. Culverts would be prescribed at rivers identified as having fish and designed and sized for fish passage in accordance with Alaska Department of Transportation and Public Facilities (ADOT&PF)

standards and US Fish and Wildlife Service (USFWS) Culvert Design Guidelines for Ecological Function (USFWS 2020).

We appreciate PLP's commitment to follow guidelines detailed in the USFWS Culvert Design Guidelines over tributaries listed in the Anadromous Waters Catalogue. Poorly designed and constructed fish passage facilities can have population scale impacts to salmon (Pess et al. 2005; Mc Clure et al. 2008). We offer caution identifying water bodies as not supporting salmon because there may be tributaries that support different life stages of salmon that have not been adequately surveyed for the Anadromous Waters Catalogue. It is well established that adult salmon move significant distances through various streams and river reaches daily and seasonally, depending on life history stage and watershed of origin (Schindler et al. 2010; Armstrong and Schindler 2013).

For the pipelines, our primary concern is the risk that the concentrate slurry pipeline or the return water pipeline could rupture and release the concentrate slurry or mine contact water into rivers and streams. According to the EFH Assessment, the concentrate slurry pipeline will have manual isolation and drain safety valves proposed at intervals no greater than 20 miles apart. The distance between manual safety valves suggests that potentially 27 tons of concentrate slurry could be released if the pipeline failed. Manual safety valves in the concentrate slurry pipeline imply response personnel need to drive several miles to manually close shutoff valves. The EFH Assessment does not describe if the return water pipeline would have safety valves, and it is also not clear if the mine contract water would be treated before returning in the pipeline or how the water and metals would be separated at the plant. Therefore, we do not know if the return water in the pipeline would contain high concentrations of heavy metals.

Rupture of either pipeline would release contaminants into salmon streams. As discussed above, low concentrations of heavy metals have detrimental impacts to salmon, persist in the environment, and move through food chains. We provide EFH Conservation Recommendations below to minimize impacts of a potential rupture to either the concentrate slurry pipeline or the return water pipeline.

4. Potential Impacts to Marine EFH

EFH is designated for salmon, groundfish, and scallops in marine waters within the project area. The EFH Assessment identifies impacts to marine EFH for species managed under the GOA Groundfish FMP and the Salmon FMP. We anticipate no potential adverse effects to scallop EFH as the current natural gas pipeline and fiber optic cable crossing Cook Inlet do not intersect known scallop beds. The project components that would adversely impact marine EFH for salmon and groundfish include a natural gas pipeline, the port facility at Diamond Point, dredging a vessel basin and access channel, the lightering operation, and vessel traffic.

Though we are less concerned about the short term impacts to benthic substrates from the physical trenching and burying of a 72 mile natural gas pipeline across Cook Inlet, we remain highly concerned about the potential for ruptures in the natural gas pipeline. Cook Inlet recently experienced a prolonged natural gas pipeline leak which released methane into the water column. While the upward cascading effects of these events on fish and the marine ecosystem are not

completely understood, natural gas leaks adversely impact marine organisms. Additionally, natural gas leaks are difficult to detect and repair in Cook Inlet. If safety precautions and response measures are not planned for and incorporated in the design and construction phase, these low probability events could have substantial adverse impacts, especially under severe winter ice conditions.

The Project Description provides the projected marine footprint disturbance: port over 21 acres; shore based facilities over 15 acres; caissons over 6 acres; dredged navigation channels over 71 acres. The port will include shore-based facilities to dewater, store, and load metal slurry concentrate, a pumping station for the water return pipeline, facilities to receive and store containers and fuel, as well as natural gas-powered generators, maintenance facilities, employee accommodations, and offices. The marine component includes a causeway consisting of concrete caissons covered with a concrete deck where fuel and concentrate will be exchanged from the storage units, to approximately two miles of conveyor belts, and finally to barges. Dredging will provide adequate depth (-18 feet below mean lower low water) for the access channel and vessel turning basin. We recognize the need to dredge Iliamna Bay to construct a port facility for this project and that lightering operations will eliminate the need for dredging a deep-water channel in Iliamna Bay.

We agree that most of the impacts from these components are limited to temporary and/or short-term impacts from construction and include disturbance and disruption of nearshore habitat and migratory zones. However, these project components impose an increased risk of concentrate/oil spills, possible leaks in the fuel and metal slurry concentrate storage units located at the port, and possible spills during lightering of concentrate or other fueling operations. Additionally, increased vessel traffic has the potential to introduce invasive species. The adverse impacts from these events would be more long-term.

These actions and their associated impacts, specific to these infrastructure components, may be greatly reduced by implementing the proposed mitigation measures in the EFH Assessment and adherence to the EFH Conservation Recommendations below.

5. EFH Conservation Recommendations

NMFS offers the following EFH Conservation Recommendations to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH. We recommend these measures in addition to the mitigation measures identified in Chapter 6 of the EFH Assessment.

Mine Site

1. Complete the post-closure plan for mine pit water treatment and management and then make it available for comment, as every indication suggests mine contact water will need to be treated in perpetuity to prevent pollution.
2. Develop a plan for recharging the aquifer surrounding the mine site with water injection wells while simultaneously keeping the pit dry. Use MIKESHE or a similar model that integrates surface flow, groundwater flow, and precipitation in a single model to demonstrate that the recharge plan is feasible.

a. The model should correctly represent: 1) point source water extraction like dewatering wells and seeps; 2) point source water inputs such as injection wells or pipe discharges; and 3) diffuse water inputs like, snowmelt, and regional inflows into deep stratum.

b. Collect more data specifically targeted to address surface and groundwater interaction with the intent to provide better results, predictions, and to use in designing measures to reduce impacts to EFH.

c. Collect more data on the lowest three geologic stratum so that they interact accurately with the unconsolidated gravel/sand stratum which provides water for upwelling and EFH.

3. Establish specific methods and procedures to identify and separate potentially acid generating from non-acid generating rock, and metal leaching from non-metal leaching rock.

4. Implement and continually monitor the effectiveness of the three-tiered system for capturing toxic water outside of the pyritic tailings and bulk tailings storage facilities and water management ponds. This recommendation is warranted because leakage of only a small percentage of water from the pyritic tailings or water management pond has the ability to harm EFH miles from the source.

    a. Liners used in pyritic tailings facilities and water management ponds should be typed and fitted for freeze/thaw conditions.

    b. Water seepage extraction wells should be located to capture all leakage above the natural baseline.

    c. Water quality monitoring wells should be placed lower in the watershed to evaluate effectiveness of the liners and extraction wells.

5. To avoid groundwater infiltration of mine contact water, the pyritic tailings liner should be built to last an additional 50 years, beyond the current 20-year project timeline. This is recommended in case future operations include mining the ore in the deeper Pebble East deposit. In this expanded scenario, the pyritic tailings cannot be returned to the mine pit as that would prevent continued operation. It would not be possible to replace the original pyritic tailings liner at that time because it will be buried under pyritic tailings.

6. Position the pyritic tailings facility and main water management plan uphill of the pit and construct them such that if the embankments fail, sludge and untreated water will flow into the pit.

7. All mine pit water and mine contact waters should be tested prior to discharge and meet all state and federal water quality standards. Regardless of the source of the mine contact water, mixing zones and site specific water quality standards should not be considered a feasible approach for discharging mine contact waters.

8. Ensure that instream flows in the South Fork Koktuli and Upper Talarik remain at pre-project levels during every month of the year.

9. Use climate scenario planning that incorporates rising winter temperatures, more frequent storms, and increased precipitation for future water management plans. NMFS recommends using the SNAP data (UA 2015) to ensure sufficient water is available during all stages of salmon life in a future climate.

Transportation Corridor

Road and Bridges

10. Conduct fish surveys to assess seasonal salmon distribution in rivers and streams transected by the transportation corridor to ensure all salmon streams receive the appropriate fish passage.
11. Design, construct, and install anadromous water crossings, such as bridges and culverts, according to the methods and recommendations found in the report "Culvert Design Guidelines for Ecological Function, Alaska Fish Passage Program" (USFWS 2020).
12. Evaluate road alignments to minimize the total road footprint within floodplains along the entire 82 miles. Transect streams at right angles and where the floodplain is narrowest.
13. Avoid gravel and sand extraction from rivers and streams known to support salmon.
14. Do a thorough evaluation of borrow pit locations along the road to minimize wetland impacts.

Concentrate Slurry and Return Water Pipelines

15. Prepare a hazardous materials spill response for the concentrate slurry pipeline given the length of the pipeline, volume of concentrate, and receiving and shipping facilities.
16. Prepare a hazardous materials spill response for the return water pipeline given the length of the pipeline, volume of contaminated water, and receiving and shipping facilities.
17. Place automated pressure-sensitive isolation valves on both the concentrate slurry pipeline and the return water pipeline on both sides of all anadromous streams. This will reduce volumes of concentrate slurry and mine contact water between valve stations.
18. Place the concentrate slurry pipeline and return water pipeline on the uphill side of the road prism and away from Lake Iliamna so that the road prism will provide initial containment in the event of a pipe rupture.
19. Stage hazardous spill response equipment at several locations along the 82 mile transit route to facilitate improved response times and further reduce impacts.

Natural Gas Pipeline

20. Prepare emergency response plans to prevent prolonged release of natural gas in marine waters of Cook Inlet, between the Kenai Peninsula and Iliamna Bay.
21. Incorporate automated emergency shutoff mechanisms and valves into the pipeline design and structure.

22. Develop emergency response plans and incorporate emergency response measures, such as subsurface shut off valves, to reduce the volume of natural gas discharge into marine waters subsequently reducing potential impacts to EFH.

Port Facility

23. Incorporate best management practices to avoid impacts to submerged aquatic vegetation and invertebrates.
24. Include plans for nearshore fish passage in construction of the Diamond Point port. Any proposed mitigation should be adequate to allow unfettered nearshore movement between Iliamna Bay and Cook Inlet for all life stages of salmon.
25. Avoid in-water work during time periods when larval and juvenile stages of FMP species are present. Additional nearshore surveys may be needed to understand the time periods when juvenile and larval life stages are present.
    a. Develop spill responses strategies for potential diesel oil spills in the port and accidental discharges of metal concentrate slurry.
    b. Ensure stakeholders are familiar with updated Alaska's Geographical Response Strategies (GRSs) to reduce and minimize risk of an oil and hazardous materials spill.
    c. Harbor facilities should be designed to include practical measures for reducing, containing, and cleaning up hazardous material spills.
26. Stage oil and hazardous spill response equipment at adequate capacities to respond based on projected volumes of materials stored or handled at the port.
27. Monitor turbidity during dredging operations and cease operations if turbidity exceeds predetermined threshold level. Use methods similar to silt curtains to limit the spread of suspended sediments.

Vessel Traffic and Lightering Operation

28. Vessel operators should be familiar with GRSs describing sensitive areas of Alaska's coastline.
29. Prepare spill response strategies for larger spills or accidental discharges of metal concentrate slurry.
30. Consult with the US Coast Guard and Environmental Protection Agency to identify and design practical mitigation measures to reduce the probability of foreign vessels introducing non-native species or pathogens into Alaska's waters.
31. Ensure vessel carriers are equipped with current technologies to further reduce the probability of vessels introducing non-native species or pathogens into Alaska's waters.
32. Ensure vessel carriers and operators are familiar with the BMPs and measures to reduce water pollution under authorities of the Nonindigenous Aquatic Nuisance Prevention and Control Act, National Invasive Species Act, and the Clean Water Act.

33. Encourage vessels to perform a ballast water exchange in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing invasive estuarine species into similar habitats. Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into nearshore and state estuarine-receiving waters.

Under section 305(b)(4)(B) of the MSA, the federal action agency is required to respond to NMFS EFH Conservation Recommendations in writing within 30 days. The response must include a description of measures USACE proposes for avoiding, mitigating, or offsetting the impact of the activity on EFH. If your response is inconsistent with our recommendations, USACE must explain the reasons for not following our recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)). Should the project, or specific components of the project identified above, change substantially in a manner that may adversely affect EFH or if new information becomes available that affects the basis for our EFH Conservation Recommendations, USACE must reinitiate the EFH consultation (50 CFR 600.920(l)).

Sincerely,

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Enclosures: References Below

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Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
DRAFT Essential Fish Habitat (EFH) Assessment					
Fed. Regulations	Draft EFH Chapter 1	1.0 Purpose/Scope	Pg. 1	*"Federal agencies must provide NMFS with an EFH Assessment if the federal action may adversely affect EFH. The EFH assessment is required to include the following: 1) a description of the action, 2) an analysis of the potential effects of the action on EFH and managed species, 3) the federal agency's view of the effects of the action, and 4) proposed mitigation, if necessary 50 CFR 600.920(e))."*	The language used here does not accurately represent the Code of Federal Regulations (50 CFR 600.920(e)(3)). NMFS recommends using the exact regulatory language regarding preparation of an Essential Fish Habitat Assessment: (e) (3) Mandatory contents. The assessment must contain: (i) A description of the action. (ii) An analysis of the potential adverse effects of the action on EFH and the managed species. (iii) The Federal agency's conclusions regarding the effects of the action on EFH. (iv) Proposed mitigation, if applicable. NMFS suggests citing 50 CFR 600.910 Definitions and 600.920 Federal agency consultation with the Secretary, as well. The process begins with the action agency's determination that the action may adverse effect EFH (see 600.920(a)(1)). Also, the level of detail in an EFH Assessment should be commensurate with the complexity and magnitude of the potential adverse effects of the action (see 600.920(e)(2)).
EFH Assessment - Chapter 3 - Proposed Action					
Fed. Regulations	Draft EFH Chapter 3	1.0 Purpose/Scope	Pg. 3	This EFH Assessment does not define "Adverse Effect"	Adverse Effect (600.910(a)) - "Adverse effect means any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions." NMFS recommends USACE clearly define "adverse effect" as defined in Federal regulations.
Mine Description	Draft EFH Chapter 3	1.0 Purpose/Scope	Pg. 3	*"The total size of the proposed mine area would be 42,300 ft (12,893 m) long by 25,600 ft (7,802.9 m) wide, covering an area of 8,085.8 ac (3,272.2 ha)."*	NMFS recommends USACE state the pit's depth, width and other pertinent pit information in the EFH Assessment as these are important for understanding the mines effects on groundwater, upwelling, and spawning habitat. It is stated in other documents, but the depth and width are inconsistent.
Project Scope	Draft EFH Chapter 3	3.0 Proposed Action	Pg. 3	*"PLP's proposed action includes activities that require DA authorization under Section 404 of the CWA and Section 10 of the RHA."*	This proposed action sections implies the action being evaluated in the EFH Assessment is only the four years of construction necessary to begin mining. The proposed action should encompass the 4 years of construction, at least 20 years of mining, and the several hundred years water treatment that must continue once active mining finishes. Each of these three parts will have significant impacts on EFH. NMFS recommends USACE/project proponents have the EFH assessment cover all actions associated with constructing, operating, and closing the Pebble Mine. As one reads through the hundreds of documents put forward over the last 14 years, it becomes clear that the 78-year mine makes more economic sense and is probably the end goal of the project proponent. NMFS recommends the project proponent evaluate the expanded 78-year mine scenario now to meet the requirements of the EFH regulations at 50 CFR subpart K - EFH Coordination, Consultation, and Recommendations.
Insufficient detail	Draft EFH Chapter 3	3.0 Proposed Action	Pg. 3	*"For this project (Figure 3-1), activities that require DA authorization under Section 404 of the CWA include: the permanent discharge of dredged or fill material into 3,555.4 acres (ac) (1,438.8 ha) of waters of the U.S."*	The largest effects to EFH will result from changes to groundwater flow, surface water flow, and both surface and groundwater chemistry. The EFH Assessment should therefore provided detailed descriptions of actions that will affect these four physical properties in a very wide circle around the mine footprint. The current proposed action seems written primarily towards section 404 of the CWA and fill in freshwater; and Section 10 of Rivers and Harbors Act. The vast majority of the proposed action is how much fill is being put where. Furthermore the description is focused on the transportation corridor and the LNG pipe rather than the mine site itself. The adverse effects on EFH from the USACE's permitting these activities must include an analysis of the impacts of the mine itself (see 600.910(a)).
Insufficient detail	Draft EFH Chapter 3	3.0 Proposed Action	Pg. 3	*Author does not address, Insufficient*	NMFS recommends USACE/project proponent include details on the depth and water level in the pit, the pyritic tailings storage facility (PTF), the bulk tailing facility (BTF) at different time frames and the dewatering plan around the mine pit.

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Extend to Impacts	Draft EFH Chapter 3	3.4 Action Area	Pg. 7	*"The Action Area for the mine site is defined as EFH that is impacted by the placement of fill in waters of the U.S., including wetlands, sedimentation associated with the placement of fill in waters of the U. S., dewatering of the open pit, and blasting, all of which are captured by a 1,000 ft (305 m) buffer around the mine site facilities. It also includes EFH that is impacted by changes in stream flow resulting from the diversion, capture, and release of water associated with the project that results in a modeled reduction in streamflow of more than 2 percent."*	This "action area" definition does not seem very relevant to evaluating effects to EFH. While the "action" may happen in the 1,000 ft buffer that does not limit the effects to that 1000 ft buffer. If you blast daily for 20 years, nitrate and ammonia will get in the groundwater. NMFS recommends the EFH Assessment cover the entire area where mine altered water might move. As stated in 50 CFR 600.910(a), adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include sitespecific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.
Water Quality	Draft EFH Chapter 3	3.4 Action Area	Pg. 7	Authors do not acknowledge that water with high concentrations of metals will escape the mine footprint.	NMFS recommends USACE/project proponent describe how far from the mine perimeter the analysis expects a 0.5 pH unit change, 0.1 pH unit change, and 0.03 pH unit change in each of the three drainages in the winter upwelling flows that nourish salmon eggs. Quantify these pH levels after 10 years of mine operation, end of 25 years, and after 100 years. Cite literature as to how salmon egg development is affected by pH change. Without this analysis, NMFS is concerned that the groundwater chemistry will change and water with extremely high metal concentrations and acid mine drainage will escape the approx. 10 mile square mine footprint. Salmon spawn in areas with upwelling groundwater, and the eggs rely on this water. NMFS cannot accurately predict effects on incubating eggs or juvenile salmon until we know the approximate level of pH change in each reach. Please provide this information about pH change based on data from other porphyry mines in the U.S. or Canada.
EFH Assessment - Chapter 4 - Managed Fish Species and EFH					
Salmon Distribution	Draft EFH Chapter 4	4.1 Pacific Salmon	Pg. 11 Table.4.2	*footnote #1: "Pacific salmon life stages present within the primary drainages within the Action Area:"*	NMFS recommends USACE/project proponent include all water bodies that might be effected within the reasonably foreseeable cumulative effects. This should include at least Koktuli River, Mulchatna River, Kvichak River and Lake Iliamna. These waterbodies will likely experience the effects of mining over the life of the mine.
Upwelling	Draft EFH Chapter 4	4.1 Pacific Salmon	Pg. 11	*"The majority of adult fish and spawning observations for all adult Pacific salmon occurred downstream of waters directly affected by proposed mine facilities (Table 4-4, Table 4-5)."*	NMFS recommends USACE/project proponent describe effects to upwelling in each drainage in February and March during a dry, cold weather (in the 30th percentile years from watershed module for both dry and cold). Cold and dry often happen simultaneous in Alaska and that stresses salmon eggs. Changes to total annual streamflow may be small but monthly changes may be large. Upwelling may not be so important mid summer, but may be critical in March to keep eggs alive.
UTC	Draft EFH Chapter 4	4.1 Pacific Salmon	Pp. 15 Table 4-5: also reported in EBD Tables 15.1-16,15.1-29,15.1-42.	*1) Upper Talarik Creek - Sockeye Salmon (2008) 177,642 individuals*	NMFS recommends USACE/project proponent provide population estimates based on standard repeatable fish inventory methods stating how many of each species of salmon returned to the Upper Talarik River in three or more of the last 10 years. Explain why/how you selected those three years. Helicopter overflights at varying timesteps with differing visibility are not a rigorous method of calculating population estimates.
Water Temperature	Draft EFH Chapter 4	4.1.2 Coho Salmon	Pg. 23	*"Although small numbers of adult fish were observed throughout the NFK River and in the SFK River up to river km 51.2 more than 90 percent of spawning observations were downstream of river km 36.6 in the NFK River ..."*	Just because a larger portion of spawning is happening lower in the main stem, that does not mean the mine's impacts on the upper tributary are not important. Water quality, water temperature, and water quantity changes upstream affect the downstream reaches. Less upwelling at the top of the watershed means the whole river freezes deeper and has less winter flow. NMFS recommends USACE/project proponent explain how they predicted how far downstream more gravels would freeze. Though recognizing altering temperatures will have cumulative impacts on early salmon life histories, there is little description of how the USACE/Project Proponents intent to mitigate these impacts. An analysis should be conducted to address the cumulative impacts of water temperature changes such as timing, size at emergence and changes in food chain dynamics in these watersheds. Then real mitigation measures should be designed to reduce these cumulative impacts in the tributary reaches where water and salmon are still present.

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Groundwater; Upwelling	Draft EFH Chapter 4	4.1.2 Coho Salmon	Pg. 24	*"They were found year-round within all three drainages and length-frequency data indicate there are at least four age classes of early freshwater juveniles (0+, 1+, 2+, 3+) within the mine Action Area (PLP 2011)."*	NMFS recommends USACE/project proponent state how many age cohorts of coho salmon are expected to die if each reach of stream is dewatered for even 12 hours. Please also state the number of cohorts that are expected to be lost to dewatering a reach for sockeye, chum, and Chinook salmon. NMFS also recommends USACE /project proponent explain how they will really know how far away a dewatering pump is having an effect. PLP models might be fairly robust, but it is still logical to monitor and physically measure the effects. If a stream reach is dewatered by pumping designed to tilt the groundwater table toward the pit, there is the potential to kill 3 or 4 age classes of coho. While the applicant plans to pump and treat water aggressively, the only way to know which stream sections will be dewatered is byvisually monitoring the small streams and the effects of dewatering on those salmon cohorts will be irreversible.
Amakdedori	Draft EFH Chapter 4	4.5 Amakdedori Port Habitat Mapping	Pg. 64	*"The backshore of Amakdedori Beach is composed of a storm berm formed by large woody debris with a broad flat riparian upland ..."*	NMFS recommends USACE/project proponent state how high Amakdedori beach berm is and the height of waves that would have been required to put that large woody debris in place. Tie this to the species of fish you expect to be present during the stormy fall sea conditions.
EFH	Draft EFH Chapter 4	Diamond Point/Insikin Bay section doesn't exist	Pg. 64	No Discussion of EFH at either alternative port location.	NMFS recommends USACE/project proponent state which species have EFH and how the project will effect that EFH, for all port options mentioned in the project alternatives (DEIS chapter 2).
EFH Assessment - Chapter 5 - Evaluation of Potential Effects on EFH					
EFH Attributes	Draft EFH Chapter 5	5.0 Evaluation of Potential Effects on EFH	Pg. 65	*There was no Author Language*	A discussion of the current regional condition of EFH is missing. NMFS recommends USACE/project proponent describe the specific EFH attributes that make streams in Bristol Bay watershed have extremely productive salmon spawning habitat. NMFS recommends including a quantitative analysis of various EFH attributes by species and life stage and explain the relative importance of each EFH attribute.
Duration of Impacts	Draft EFH Chapter 5	5.0 Evaluation of Potential Effects on EFH	Pg. 65	*"This EFH analysis considers four categories of duration: temporary, short-term, long-term, and permanent.* *• Temporary – days to weeks* *• Short-term – < 3 years* *• Long-term – > 3 years to < 20 years* *• Permanent – > 20 years or no recovery"*	NMFS recommends adding •Very Long-term – > 20 years to < 200 years between long term and permanent as this projects has lots of effects that fit in this timespan.
Not Clear	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pg. 66	*"Construction at the mine site would discharge fill material into 46,836 LF (14,276 LM) of EFH"*	NMFS recommends for all linear numbers greater than 1,000 feet, please express them to the nearest 1/10 of a mile or kilometer. This makes it easier for everyone to understand.
EFH Attributes groundwater Upwelling	Draft EFH Chapter 5	5.1.1.7 Summary of Mine Site Potential Effects to Freshwater Ecosystem EFH	Pg. 82 Table 5-5	*Water Flow - Predicted stream flow changes - Permanent - "The degree of impact is low: - Overall, changes would be permanent and range from low to slightly positive for some specie in terms of both spawning and rearing habitats. -NFK River – up to low level of impact to Chinook salmon EFH quantity and quality. -SFK River – up to low level effect on EFH quantity and quality. -Generally positive effect on sockeye salmon spawning and rearing habitat."*	This quote relates impacts to water flow and effects on EFH, but these are distinct impacts. In many reaches the flow will be different during mine operation, but perhaps not drastically changed once the process water is returned to the stream and post-mine, the total stream flow may be similar. But there will likely be less upwelling or upwelling in fewer locations, and upwelling is the EFH attribute that is most important to juvenile rearing and survivability of salmon. In terms of effects to EFH, NMFS recommends the USACE/project proponents redo their analysis, especially incorporating analysis of effects to upwelling (see comment about pgs 66 & 67). Upwelling through gravel and water chemistry are very important to EFH. Upwelling will decrease and the waters will have more metals and likely lower pH as a result of the mine. Both of these impacts will drastically decrease quality and quantity of EFH in the tributaries closest to the mine. In the mainstem of the NFK and SFK, it is difficult to ascertain the level of effect. The most likely scenario is the water quality effects will start out minor, but increase with each passing decade as the tailing piles become acidic and the liner and other barriers become less effective.

Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Loss of Habitat	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pg. 66	*"Construction of the mine site (September Y2 – October Y4) would remove 46,836 LF (14,277 LM) (13.6 percent of EFH within Action Area) of designated EFH within the NFK and SFK tributaries of the Koktuli River; no EFH would be removed in UT Creek (Table 5-1). The total loss of EFH represents a 3 percent loss of the 1,573,510 LF (479,606 LM) of EFH in the Koktuli River drainage (Table 5-1)."*	Mine construction includes removal of overburden, which will affect Upper Talarik Creek (UTC) EFH. Flow through the overburden at the edge of the pit feeds upwelling areas in UTC. NMFS recommends USACE clarify both how many miles of stream will be buried (that is complete), and how many miles will be effected in lesser ways. One cut off might be to assume any reach with 10% of its watershed falling in the zone of influence (not just drawdown cone) would likely see altered flows. Water quality problems could affect an even larger area. 97% of the Koktuli EFH streams miles may appear visually similar during mining, however their value as EFH will be greatly compromised as this mine operation changes water quantity, chemistry and temperature.
Loss of Habitat	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pgs. 66 & 67	*"The magnitude of the potential mortality to Pacific salmon in streams directly impacted by construction activities will depend on construction timing and presence of Pacific salmon life stages, including eggs, juveniles, and adults. Juveniles and embryonic life stages would be more susceptible to mortality than adult Pacific salmon. The NFK and SFK reaches that would be removed have a* **low Pacific salmon presence compared to downstream reaches indicating that these habitats are of lower quality EFH or not limited in abundance in the remainder of each drainage**." "The physical loss of habitat would be low overall and juvenile salmon densities observed within the reach to be eliminated indicate the loss would have negligible consequences to managed species." "Direct impacts of EFH removal would be permanent. However, considering the low use of EFH to be removed (based on densities of juvenile Chinook, coho and sockeye salmon captured within these habitats), the lack of spawning in SFK-E reaches to be removed and the low level of spawning in the NFK 1.190 tributary to be removed, indicates that drainage-wide impacts to Pacific salmon populations from these direct habitat losses would be unlikely."	The approach to determining fish species distribution did not follow standard fishery science methods and although Habitat Suitability Curves (HSC) are an excellent tool, the project proponent did not correctly apply that tool. Below are five recommendations to partially remedy many years of looking for fish without having a peer reviewed study design. 1) While NMFS knew fish surveys were being conducted, NMFS was not provided information on survey objectives, statistical design, and supporting sampling methods used to inform the analysis or that conclusion. There is no evidence that survey designs and results were vetted or peer reviewed. NMFS recommends having an independent third party (academia) review the fish survey information and state its accuracy and precision both for determining distribution of adults and juvenile life stages. 2) Aerial surveys are a qualitative method not a quantitative method. The full range and distribution of each of the five pacific salmon, in each of their fresh water phases was never truly established. NMFS recommends project proponent vet survey methods with the resource agencies and apply them to all the small tributaries during the 2020 summer. Since we all agree the larger streams are teaming with salmon, these are a lower priority. 3) Regarding Habitat Suitability Curves, robust HSCs should not be based solely on instream flow levels and/or velocities. NMFS recommends creating new habitat suitability curves where EFH attributes are initially tested for (substrate, upwelling, velocity, depth, presence of food source, cover, etc) and the scientific approach is used to determine the most important attributes. These should be based on field work done in Alaska, and perferably near the Pebble site. 4) To the best of our knowledge only main stem channels were surveyed for adults, and data was only collected where the adult salmon were located. There was no data collected where the adult salmon were not located. Though this may seem counterintuitive to accurately assess habitat suitability based on habitat variabilities, analysis needs to be completed on why salmon where not in specific stream reaches for specific conditions. NMFS recommends applying the Habitat Suitability Curves as they were designed to be used and compare 5 - 6 attributes across where fish are and are not present. 5) HSC variables were not collected for off channel, secondary and tertiary streams that provide rearing habitat to fry and juveniles. NMFS recommends HCS curves be developed for all life stages after detailed on-the-ground surveys determine where fry and juveniles are rearing. This should also be done in adjacent areas without 1,000 drill holes, as contamination from leaking holes could have already made these areas unappealing to juvenile fish. The survey methods and analysis used to determine salmon presence in these stream reaches closest to the mine site, do not defensibly support the conclusion made that these stream reaches are of "*low biological importance*". These comments are also reflected in comments for Section 7 conclusions and are expanded in the Fish Distribution and EFH Attributes spread sheet.

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Water Quality	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pg. 67	*"Approximately 39,524 LF (12,047 LM) of NFK-C, primarily within NFK 1.190, would be removed, 22,938 LF (6,992 LM) of which are documented as low-use spawning habitat for coho salmon" (Table 4-4, Table 5-1, , Figure 4-4).*	NMFS recommends that USACE/project proponent acknowledge that when an applicant uses approximately four square miles of the headwater valleys of NFK 1.19 and NFK 1.2 for pyritic and bulk tailings piles respectively, there will be downstream effects. Mine water can be treated to meet federal and state clean water standards (EFH, pg 83) and returned to the creek, but that does not mean it will create the same incubation environment for salmon eggs. NMFS is concerned that not 100% of mine drainage will be captured and treated and that the water treatment plants may not always meet the standards. The analysis should acknowledge these possibilitites.
Loss of Habitat	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pg. 68	*"The Koktuli River and the Upper Talarik Creek drainages include 2,033,856 LF (619,919 LM) of stream." ... "Overall, the degree of habitat loss impact is moderate"*	The analysis indicates that the cumulative effects of processing even 75% of the projected ore body (Graffari 2011) would severely degrade most of the 47 miles identified. It is not clear how degrading approximatly 47 miles of stream would result in a moderate degree of habitat loss. NMFS recommends USACE compare this loss of habitat to the miles of sockeye and Chinook salmon habitat eliminated or compromised by other development projects in Alaska. NMFS also recommends USACE/project proponent state how many fewer juvenile salmon will outmigrate over the first 100 years. Present these numbers both for the 25-year plan and the 78-year plan described in the cumulative effects portion of the DEIS Executive Summary. NMFS recommends USACE/project proponent present this quantitative loss of outmigrating juveniles to the Alaskan public so they can have an informed opinion.
Blasting	Draft EFH Chapter 5	5.1.1.2 Blasting	Pg. 69	*"Occasionally, blasting could occur within the Action Area near fish-bearing waters along EFH tributaries"*	Blasting leaves an ammonia and nitrate residue on the surrounding rocks/ground which compromises water quality and degrades fish habitat. This project proposes 25 years of daily to weekly blasting as the pit is deepened. NMFS recommends USACE explain the fate of the ammonia and nitrate residue from thousands of blasts. NMFS recommends USACE/project proponent explain why rainwater will not mix the ammonia and nitrate into the groundwater.
Blasting	Draft EFH Chapter 5	5.1.1.1 Loss of Habitat	Pg. 69	*"Occasionally, blasting could occur within the Action Area near fish-bearing waters along EFH tributaries of NFK River and the headwaters of SFK River north of Frying Pan Lake (Figure 3-10). The use of explosives near occupied fish habitat can produce in-water overpressures and in-gravel particle velocities that could injure or result in mortality to fish and fish eggs in spawning gravels."*	Blasting produces byproducts of nitrates and ammonia which promote algae growth and lower the dissoloved oxygen if they enter the water. While each blast only creates a few ounces of these byproducts, thousands of blasts over 20 years could create a problem. Explosives can create in-water overpressures in gravel containing fish eggs and kill those fish eggs. Without knowledge of the size of the blasts or exactly which tributaries have spawning fish the effects to EFH are hard to evaluate. NMFS recommends the project proponents consult an acoutiscian to determine how far from the blasting area eggs could be compromised in gravels.
Water Temperature; upwelling	Draft EFH Chapter 5	5.1.1.3 Water Flow	Pg. 72	*"Mine infrastructure within the UT Creek drainage would be limited to roads and water treatment plant discharge facilities. Changes to mean annual surface water flows in UT Creek could be affected by pit dewatering activities, however the net result of pit dewatering and treated water discharge from water treatment would be an estimated increase of 1 percent at site UT100D, nearest the discharge facilities. Mean annual surface water flows for sites downstream from UT100D are predicted to remain the same as premine flows (Table 5-2)."*	NMFS recommends USACE/project proponent substantiate why water quantity in UTC will increase by 1%. In earlier documents, PLP has said up to a third of water in UTC comes from groundwater transfers from SFK. Mid-winter flow in the UTC tributaries used to be sustained by the 100-foot thick overburden slowly discharging water to these tributaries both as upwelling and through springs. NMFS recommends USACE explain what percent of the contributing overburden will be remove and how that lack of groundwater will affect flows and mid-winter temperatures in the UTC tributaries? As presented earlier
Project Scope	Draft EFH Chapter 5	5.1.1.3 Water Flow	Pg. 72	*"Changes in streamflow described above can affect EFH quantity and quality, however, because net reductions in flow are relatively small, changes in available Pacific salmon spawning and rearing habitat are expected to be equally small. Potential impacts to spawning and rearing habitats for Pacific salmon were modelled for wet, dry and average precipitation years post-construction with treated water discharge."*	Since the 78-year mine plan appears executable by the project proponents and makes economic sense, NMFS recommends USACE/project proponent also analyze that plan. NMFS recommends an analysis of the effects of dewatering wells necessary to keep the 78-year mine pit dry for the life of the mine.
Project Scope	Draft EFH Chapter 5	5.1.1.3 Water Flow	Pg. 72	*"Mine infrastructure within the UT Creek drainage would be limited to roads and water treatment plant discharge facilities. Changes to mean annual surface water flows in UT Creek could be affected by pit dewatering activities, however the net result of pit dewatering and treated water discharge from water treatment would be an estimated increase of 1 percent at site UT100D, nearest the discharge facilities. Mean annual surface water flows for sites downstream from UT100D are predicted to remain the same as premineal flows (Table 5-2)."*	Based on 15 years of mine plans focused on the pebble deposit and the cost of developing the infrastructure to get the ore to market, NMFS questions whether the 20-year plan is the intent of the applicant. NMFS recommends all analysis be done consistently on both the 25-year plan and the 78-year plan.

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Surface Water	Draft EFH Chapter 5	5.1.1.3 Water Flow	Pg. 72	*"Changes in streamflow described above can affect EFH quantity and quality, however, because net reductions in flow are relatively small, changes in available Pacific salmon spawning and rearing habitat are expected to be equally small. Potential impacts to spawning and rearing habitats for Pacific salmon were modelled for wet, dry and average precipitation years post-construction with treated water discharge."*	NMFS recommends USACE/project proponent focus particular attention on low flow time periods like February/March and perhaps other dry periods as the climate changes. It is true that during spring melt and during rainy months these small changes will have minor effect. Even a 1 cfs decrease in a small stream at the driest time of year can desicate and kill salmon eggs.
Water Quality	Draft EFH Chapter 5	5.1.1.5 Water Quality	Pg. 80	*"The introduction of this metal and mineral rich runoff or acid mine drainage (AMD) into the aquatic ecosystem can have adverse impacts on the ecology of entire watersheds. AMD can also lower pH that can negatively impact Pacific salmon populations by acute and chronic exposure. Pacific salmon are vulnerable to low pH when undergoing the physiological changes that occur during smolts' transition from freshwater to salt water and adult spawners' transition from saltwater to freshwater (Chambers et al. 2012)."*	There is an understanding, based on the nature of hardrock mining, that eventually these tailings and the pit will become reactive in the presence of oxygen and water. Though that reaction starts slowly in different places, it gradually builds and increases over time eventually overwhelming water management systems that were designed to retain, control, mitigate and buffer the reaction. Mining operations in Alaska and the Northwest that process higher quality ores (lower stripping ratio), in regions with less seasonal precipitation and less ground and surface water interaction (drier regions with different geology), have exceeded permitted discharges of metals leaching from "waste rock facilities" (metals such as selenium, cadmium, chromium, lead and mercury,mobile disolved metals, etc). The applicant's operations plans basically says they will use the same methods and processes used by most other modern porphyry mining operations in the U.S. and Canada, except on a larger scale. This would suggest that sooner or later similar water quality issues will arise. NMFS recommends USACE/project proponent expand this section to explain how each of the water quality problems (pH, selenium, cadmium, chromium, lead and mercury, mobile disolved metals, etc) present in the Berkeley pit and other large porphyry mines will be avoided for Pebble. The project proponent needs to do better than slow down or delay the reactive process by submerging toxic tailings at the bottom of the mine pit lake. If they are only delaying the reactive process, this whole discussion is about when the SFK, NFK and UTC will become fishless, rather than if they will become fishless.
EFH Assessment	Draft EFH Chapter 5	5.1.1.6	Pg. 81	*"Studies have shown that salmonids exposed to sublethal levels of metals are susceptible to increasing levels of fish pathogens due to stressed immune responses and metabolisms (Jacobson et al. 2003, Spromberg and Meador 2005)."*	The project proponents claims that all discharges will meet federal standards. These federal maximum metal concentrations can still be much higher than natural levels, however, they would probably not affect spawning adults. For a coho and sockeye whose eggs, fry and juveniles will be bathed in this metalic water for 18 to 42 months, those juvenile fish may experience effects of metal accumulation, outmigrate smaller and have lower ocean survival, even if water quality standards for metals are met most of the time. NMFS recommends the project proponent provide background data that shows juvenile salmon raised in waters at the federal metal limits do not show decreased growth or other problems.
Mine Site	Draft EFH Chapter 5	5.1.1.7 Summary of Mine Site Potential Effects to Freshwater Ecosystem EFH	Pg. 82 Table.5-5	*Water Quality: The degree of impact is low - Wastewater would be treated and tested for compliance with federal and state clean water standards prior to discharge to streams.*	Every copper mine in the world sooner or later degrades water quality in the local streams. The vast majority of copper mines degrade it so far as to extripate fish species for several miles. NMFS finds this mitigation that "wastewater would be treated and tested for compliance with federal and state clean water standards" insufficient as some water will seep into the ground without being treated. Secondly, most mine water treatment plants have track records that suggest on many days they do not meet standards for at least one parameter. NMFS recommends the project proponent expand its EFH analysis using clear assumptions of the percentage of water bypassing treatment altogether and the percentage of days treatment plants violate one or more standards. This mine site will have miles of large diameter pipe moving water around. Pipes will leak, and occaisionally they will rupture. NMFS recommends the project proponent explain how they will recapture this untreated water once it seeps into the dirt.

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Water Quality	Draft EFH Chapter 5	5.1.1.7	Pg. 83 Table 5.5	*Table 5.5 Summary of potential impacts to freshwater ecosystem EFH in the mine site area - Potential metals increase in water quality as a result of acid mine drainage. - The degree of impact is low*	NMFS disagrees that the degree of impact is low. In most porphyry mines the impact starts out appearing "low" but decade after decade more miles of streams become fishless and sterile. Waterhsheds, like individual organisms, bio-accumulate metals and acidity, but over longer timeframes. NMFS recommends USACE/project proponent list this impact as high. Further it is safe to assume Pebble will follow the trajectory of other mines constructed in similar rock and of similar size. NMFS recommends the the project proponent do a literature search of five similar mines (salmon watersheds with similar groundwater dynamics) and briefly explain the data showing their track record as to whether the surrounding streams exhibited lowered pH or higher concentrations of metals.
Transport Corridor	Draft EFH Chapter 5	5.1.2.1.1 Fish Passage and Habitat Loss	Pg. 84	*"Culvert design and construction will meet guidelines contained in the ADF&G and the ADOT&PF Fish Passage Memorandum of Agreement (ADF&G and ADOT&PF 2001):"*	NMFS recommends the project proponent design and cost-out each waterbody crossing following the guidelines in U.S.F.S Aquatic Organism Passage at Road-Stream Crossings, 2018. Using this newer guidance will significantly reduce adverse effects on EFH.
Water Quality	Draft EFH Chapter 6	6.4 Water Use	Pg. 116	*"Water quality necessary to support fish populations will be maintained by monitoring and adjusting water temperature, sediment loads, and pollution levels in compliance with APDES."*	A more exacting statement might be "During active mining and when the mine is making money, the operator will do everything within their power to maintain water quality in compliance with APDES." The metals and acid mine drainage problems could grow to a magnitude where there are no technical fixes that can be employed on this scale in this remote location. NMFS recommends the project proponent provide a detailed plan for the annual cost of post closure water treatment, what enitity will actually do the work, and where the operators of the water treatment plant will dispose of the metals they remove.
Closure	Draft EFH Chapter 6	6.10 Compensatory Mitigation Plan	Pg. 118	*PLP has prepared a Draft Compensatory Mitigation Plan (CMP) to fulfill the requirements established by the USACE regulations (33 CFR 320.4(r) and 40 CFR 230). The plan includes a framework for selecting resources mitigation projects that will primarily aquatic focus on opportunities that benefit water quality and enhance or restore fish habitat.*	How does this "draft" plan provide assurances that resources mitigations projects will happen? At closure there will still be no clear knowlege of how many miles of stream habitat have been destroyed. This CMP plan is not listed in the references for the EFH Assessment or on the USACE Pebble site. NMFS recommends the project proponent provide their CMP to the public and explain how they will mitigate damages that may not even be understood or seen in our lifetimes.
Conclusions	Draft EFH Chapter 7	7 Conclusions	Pg 119	*"Habitat removed is generally of low biological importance"*	Project Proponents did conduct an array of fisheries related surveys (relative abundance and index surveys using aerial methods for adults). However, these methods, types of surveys, and lack of consistent systematic application do not provide the statistical precision and accuracy to support the conclusions of "Moderate, Low, and Negligible" impacts to salmon (Section 7, Conclusions Table 7-1). Independent surveys conducted recently by ADFG, found salmon juveniles in tributary reaches beyond reaches identified by project proponent contractors. NMFS recommends the USACE include recently established fish surveys data, implement defensible surveys to identify the range and distribution of salmon in these headwater reaches (see Fish Distribution spread sheet), or change the conclusions in Section 7.
Water Quality	Draft EFH		Global	The word "metals" appears in the EFH assessment, but rarely.	The draft EFH Assessement states the first four years of construction can be done with only a low chance of introducing significant metals into the environment; NMFS agrees. NMFS recommends USACE/projet proponent focus on pathways for metals getting into the UTC, SFK and NFK during the 20 years of active mining, during closure, and during the hundreds of years the pit lake will sit there. Specifically focus on how those elevated metal levels will affect salmon EFH.
DRAFT ENVIRONMENTAL IMPACT STATEMENT					
Project Scope	Draft EIS (DEIS) Executive Summary	1.3 Project Overview	Pg. 2	*"The operations phase would last 20 years."*	Though the Executive Summary (ES) suggests a 20-Year operations phase, other sections of the ES and D-EIS identify and discuss an expanded 78-year mine plan. NMFS recommends USACE/project proponent thoroughly analyze the cumulative impacts of the 78-year plan at this same Pebble deposit by this same mining group. Other sections of the ES address Reasonable Foreseeable Future Actions (RFFA's), clearly identify 6 other mines in the immediate region that would all be supported by this projects infrastructure. NMFS recommends USACE/project proponent broadly analyze the likely scenario that once the ports, road, and LNG pipeline open up Kvichak and Nushagak watersheds to mining, several ore deposits similar to Pebble will likely be mined in the next 200 years.

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Water Quality Extent of Impacts	DEIS Executive Summary Maest et. al 2005 Morin et. al 1995 Kempton and Atkins 2000		Pg. 7	*"The pyritic TSF would also be used to store potentially acid-generating (PAG) waste rock during operations."*	The DEIS acknowledges the potential for Potentially Acid Generating (PAG) waste rock; the project therefore includes a pyritic tailings pit. It does not estimate how long that PAG material will remain in the environment, and this information is necessary for NMFS to assess the effects of the PAG on EFH. The length of time over which a mine site will deviate from baseline or pre-mining conditions will be on the order of centuries to tens of thousands of years, as a result of potential delays in the generation or appearance of acid drainage (e.g., Morin et al., 1995; Kempton and Atkins, 2000). It is very unlikely for the tailings pit to completely contain the PAG for its entire lifetime and not release any into the surrounding environment. At 1,500 feet below the surface near the pit, there is at least one known area of very high hydraulic conductivity. Any area of high hydraulic conductivity is very likely to allow for release of acid mine drainage. NMFS advises the project proponent assess the potential lifetime of the PAG and its effects on the environment.
Water quality	DEIS Executive Summary	2.2 Action Alt 1 - Applicant's Proposed Alternative Mine Site	Pg. 7	*"...pyritic tailings (approximately 1,071 acres) would be located primarily in the North Fork Koktuli (NFK) watershed" . Footnote # 2 "Pyritic tailings are composed of potentially acid-generating finely ground rock material containing the naturally occurring mineral pyrite that remains after economic minerals have been extracted through mineral processing at the mine site."*	Pyritic tailings have the potential to become acidic by definition. This facility is estimated to be 1,071 acres and and will contain approximately 150,000 acre feet of pyritic tailings by year 20. NMFS recommends the USACE/project proponent clearly acknowledge that the Pebble mine is likely to create acid mine drainage rather than putting it in footnotes. Acid mine drainage adversely impacts EFH.
Fish Passage	DEIS Executive Summary Chapter 2	2.2 Action Alt 1 - Applicant's Proposed Alternative Transportation Corridor	Pg. 9	*"culverts at streams with fish would be designed and sized for fish passage in accordance with regulatory standards."*	Considering this is referring to over 150 culverts and bridges, NMFS can not evaluate an EFH Assessment without more detail on the designs. The U.S.F.S. Aquatic Organism Passage at Road-Stream Crossings, 2018, is some of the strongest guidance for protecting EFH. NMFS requests that the project proponent provide the exact standards they intend to follow and then complete the EFH assessment using those standards.
Site Closure	DEIS Executive Summary Chapter 2	2.2 Action Alt 1 - Applicant's Proposed Alternative Mine Site	Pg. 8	*"Physical site closure work would commence as operations end. At that time, the Amakdedori port facilities would be removed, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies."*	NMFS recommends USACE require some financial mechanism to make sure funds are set aside for closure and that proper closure actually happens. Nobody currently in the federal or state workforce is likely to be around when closure happens. If they go with the 78-year operating plan, then working on this issue today will still be alive. Considering the majority of plans drawn up concerning the Pebble Project since 2004 have stated a longer mine life, NMFS has reason to be skeptical.
Site Closure	DEIS Executive Summary Chapter 2	2.2 Action Alt 1 - Applicant's Proposed Alternative Natural Gas Pipeline	Pg. 13	*"The natural gas pipeline would be maintained through operations to provide energy to the project site. If no longer required at closure, the pipeline would be cleaned; and either abandoned in place or removed, subject to state and federal regulatory review and approval at the decommissioning stage of the project."*	NMFS recommends USACE require some financial mechanism to make sure funds are set aside to remove the LNG pipeline once the LNG supply is exhausted.
Amakdedori; EFH	DEIS Executive Summary Chapter 2	2.3 Action Alt 2 - North Road and Ferry with Downstream Dams Action Alt 2 - Pile-Supported Dock Variant	Pg. 20	*"The conceptual structure would consist of 44 trestle piles and 474 dock piles, for a total of 518 piles. All piles would be 48 inches in diameter, with a 1.5 inch wall thickness. The piles would be vibrated into place and then driven to refusal with an impact hammer."*	Five hundred and eighteen 48-inch piles is more 48-inch piles than have been driven in Alaska in the last 20 years. When each is set with an impact hammer, juvenile fish in the immediate vicinity will die from the sound pressure waves. NMFS recommends USACE/project proponent provide the mitigation measures and timing they plan to employe to mitigate these effects to EFH. This is the same information NMFS requests from any other USACE permit applicant requesting to construct a dock.
Project Scope	DEIS Executive Summary Chapter 3	3.0 Environmental Analysis	Pg. 25	*"Cumulative effects are interactive, synergistic, or additive effects that would result from the incremental impact of the proposed alternative when added to other past, present, and reasonably foreseeable future actions (RFFAs) regardless of what agency (federal or non-federal) or person were to undertake such other actions. A summary of existing environment and potential..."*	NMFS recommends the USACE/project proponent address "cumulative effects" as defined here. This is the appropriate level of analysis, not only in the EIS, but also in the ground and surface water hydrology, water quality and quantity, fisheries, and invertebrates sections of the EFH assessment. These items are all EFH attributes.
Groundwater	DEIS Executive Summary Chapter 3	3.2.1.2 Groundwater Hydrology	Pg. 36	*"Below the weathered bedrock, bedrock permeability generally decreases with depth, but includes some higher-permeability zones associated with faults. Some faults act as flow barriers, while others appear as flow conduits, resulting in the potential for compartmentalized groundwater flow with the bedrock at depth."*	NMFS recommends that USACE/project proponent thorougly map and characterize every fault, fracture and joint within five miles of the 78-year mine pit. Water finds the path of least resistance. If four of five faults or fractures are flow barriers, but just one is a flow conduit, the water will quickly move away from the mine site. The faults are the biggest factor in how far water quality impacts will spread and the project proponent hasn't expended the effort to characterize them individually. Schlumberger 2011a and Schlumberger 2015a do identify a few faults, but the EIS preparers do not bring this information forward.

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Project Scope	DEIS Executive Summary Chapter 3	3.2.2.1 Surface Water Hydrology Cumulative Effects	Pg. 40	*"The Pebble mine expanded development scenario project footprint would impact a much larger area than the proposed Action Alternative 1; with an expansion into the UTC watershed."* *"The expanded development would contribute to cumulative effects on surface water hydrology through increased capture of surface water flow, increased groundwater pumping to facilitate required pit dewatering, and an extended duration of these effects during operations. The magnitude of the cumulative impacts would vary from temporary to permanent, increasing potential streamflow reductions in the NFK, SFK and UTC watersheds beyond those described for Action Alternative 1." (the first sentence is in three spots)*	NMFS recommends that USACE/project proponent focus their analysis on how the expanded mine scenario will affect UTC watershed and the EFH in Lake Iliamna and Kvichak River. A careful examination of the mine proposal shows that the applicant has worked diligently to move both known impacts and known risk elements out of UTC watershed and mostly into NFK watershed. The mine proponents have responded to public concern about protecting Lake Iliamna and the Kvichak River. If the expanded mine scenario goes forward, 90% of the impacts carefully moved north will also need to take place in UTC watershed.
Project Scope Groundwater Modeling	DEIS Executive Summary Chapter 3	3.2.2.2 Groundwater Hydrogeology Cumulative Effects	Pg. 40	*"The Pebble mine expanded development scenario would correspond to roughly a five-fold increase in the size of the pit capture zone straddling the SFK and UTC drainages. There would be a similar increase in the amount of groundwater needing to be dewatered and treated during operations, and the amount pumped and treated throughout post-closure to maintain hydraulic containment in the pit lake. Streamflow reductions in SFK and UTC due to the expanded pit capture zone are expected to be somewhat mitigated by treated water being returned to these watersheds.*	A fivefold increase in the size of the capture zone would create and even larger increase in the "zone of influence" where the water table is altered. A deepening of the pit past 3,000 feet would penetrate rock stratum and fracture zones where the project proponents have too little information to build an effective model. NMFS recommends that before USACE/project proponent starts to analyze this expanded development scenario, they first collect a lot more aquifer/fault information and use that information to calibrate and validate the groundwater model.
Groundwater Water quality	DEIS Executive Summary Chapter 3	3.2.2.3 Water and Sediment Quality Action Alternative 1 and Variants	Pg. 43	*"It is estimated it would take 20 years for the groundwater in the pit to reach the maximum management (MM) level (890 feet above mean sea level {amsl}). The groundwater level in the pit would be maintained during closure and post closure to create a permanent groundwater sink to prevent pit lake contact water from discharging to the environment. This would result in a permanent pit lake that would be pumped to maintain the MM level."*	The pit is 15 miles from Lake Iliamna but will have a permanent head of up to 500 feet of water at an elevation of 890 feet a.m.s.l. Lake Iliamna is at 46 feet a.m.s.l. At some point in the next 200 years there will be an earthquake and new fractures will open up. NMFS recommends USACE/project proponent explain in the EFH assessment what steps would be taken to staunch such a flow towards Lake Iliamna or South Fork Koktuli, and how many months would it take to implement this staunching action? Most large surface water bodies interact with the surrounding groundwater. This analysis suggests that this interaction between the pit lake and the groundwater can be completely severed or at least controlled by the dewater wells which are not yet designed. NMFS recommends that USACE/project proponent provide examples of other large mine pit lakes where this complete isolation has been successful.
EFH	DEIS Executive Summary Chapter 3	3.3.1.1 Fish and Aquatic Habitat North Fork Koktuli River	Pg. 45	*"Upstream of the mine site, the NFK contains equal proportions of riffle and run/ glide habitats, with increasing frequency of beaver-formed pools. Off-channel habitats, which include side channels, percolation channels, alcoves, isolated ponds, riverine wetlands, and beaver ponds, are hydrologically connected to the NFK via surface flows or groundwater upwelling."*	NMFS recommends that USACE/project proponent provide a detailed quantitative description of EFH habitat upstream of the mine site (upstream of NFK 1.2) and make a determination of whether adult salmon will still arrive at this area. As the chemical scent of the upper reaches of the NFK-C and NFK-D change, will fish learn to recognize a new water scent and still migrate to these streams?
Project Scope	DEIS Executive Summary Chapter 3	3.1.2.2 Cultural Resources - Cumulative Effects Ghaffari 2011 pg 277	Pg. 40 Fig 18.1.5 Fig 18.1.6	*"The Pebble mine expanded development scenario project footprint would impact a much larger area than the proposed Action Alternative 1; with an expansion into the UTC watershed." The Northern Dynasty Report (Ghaffari, 2011) includes expansion into Upper Talarik as a natural next step. Graffari 2011, pg 277, Fig 18.1.5 shows the riches deposit (>1% cuEQ) will not be reached in the first 25 years.*	National Environmental Policy Act (NEPA) does not dictate what development should or should not happen, nor what natural resource tradeoffs are acceptable. It does require the applicant to honestly describe the tradeoff neccessary and the true scope of the project. The project proponent will not halt mining operations just when they arrive at the richest ore deposits. NMFS recommends USACE/project proponent analyze the mining scenario most likely to play out. The valuable ore did not move between 2011 and 2019; it is still under the headwaters between UTC and SFK. The EIS and EFH Assessment should be based on the mining scenario most likely to happen.
Spilled reagents	DEIS Executive Summary Chapter 3	3.5.1 Spill Impacts Analysis	Pg. 66	*"Potential spills of natural gas and chemical reagents were deemed to be highly unlikely and of low consequence, and are addressed briefly."*	There will be thousands of gallons of various chemical reagents on the mine site, and over the life of the mine some will spill. If the mine operator is paying attention, the contaminated soil will be excavated and probably dumped in the pyritic tailings storage facility. While this may be a logical mitigation, it greatly complicates determining chemistry in the pyritic tailings facility. NMFS recommends the project proponent list all chemicals with over one drum on site and explain the steps that will be taken to mitigate the effects of a spill. Are there any chemical spills where the contaminated soil would be transfered off site?

Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Spilled Reagents	DEIS Chapter 4	4.27.5.1 Fate and Behavior of Spilled Reagents	Pg. 4.27-59	*Spill Risk 4.27.5.1 reviews the function and general properties of each reagent, and describes the general fate and behavior of spilled reagents. "Detailed impact analyses of potential scenarios for reagent spills are not included because this is effective secondary containment for reagents, so that the probability of a reagent being released into the enviornment would be extremely unlikely."* *"Soluble reagents would dissolve if spilled into water, and could become bioavailable for a limited time, and potentially toxic to aquatic resources. Reagents that are insoluble or not immediately soluble could have long-term impacts to aquatic resources if not removed from water (PLP 2018-RFI 052)."*	Soluble reagents could quickly become bioavailable and potentially toxic to aquatic resources. This being Alaska, the spills will happen when it is raining. NMFS recommends the project proponent list the soluble reagents, the volumes stored on site, and the mitigation procedures should a spill happen.
Draft Environmental Impact Statement - Chapter 2 - Alternatives					
Water Quality Climate Change	DEIS Chapter 2	2.2.2.1 Mine Site - Physical Reclamation and Closure	Pg. 2-39	*"The mill, pyritic TSF, main WMP, and other infrastructure not required for post closure would be removed from the site, and/or reclaimed as part of the site closure and reclamation."*	The 24-hour max precipitation value for a 100-year return period is likely to become the 25-year return period before the pit is filled (40 years) due to more intense storms. That suggests that for a 10-square mile mine footprint, the project would need to deal with 7 inches of rain spread over 6,400 acres in 24 hours (Knight Piesold 2018g). This is approximatly 3,733 acre feet of water storage that needs to be constantly available. The design 44 cfs capacity for water treatment only allows treatment of 88 acre feet a day. NMFS recommends USACE/project proponent explain where is this storage capacity once the main WMP is closed and reclaimed? If they can't store it, this mine contact water will flow into the groundwater aquifer and dimish EFH when it surfaces in upwelling and springs.
Surface Water	DEIS Chapter 2	2.2.2.1 Mine Site - Post Closure Management	Pg. 2-41	*"Once the level of the pit lake has risen to the control elevation (about 890 feet), water would be pumped from the open pit, treated as required, and discharged to the environment."*	The pit lake will be maintained at about 890 feet a.m.s.l. NMFS recommends USACE/project proponent provide a map that shows all springs, lakes, tarns, and creeks above this elevation that will lose water towards the pit. Describe which ones you expect to be dry the majority of the year in perpetuity. Provide a similar map for the 78-year pit.
Site Closure Water Quality	DEIS Chapter 2	2.2.2.1 Mine Site - Financial Assurance	Pg. 2-41	*"A detailed reclamation and closure cost model would be developed to address all costs required for both the physical closure of the project, and the funding of long-term post-closure monitoring, water treatment, and site maintenance"*	The details of reclamation and closure costs should be known before the Record of Decision (ROD) is signed. If the cost of closure and treating water in perpetuity is unknown, how can the resource agencies be asked to believe reclamation will happen? Knowing whether the contact water is/is not treated in perpetuity is crucial to completing an EFH assessment. Without forever treatment, the pit would discharge the majority of AMD down the SFK where would collect in the large gravel aquifer. Approximately 1/3 could move through groundwater transfer over to the Upper Talarik watershed. AMD will kill fish in either drainage. NMFS recomends USACE require a detailed reclamation plan and a logical explaination of how water treatment in perpetuity is funded before the EFH assessment is finalized.
Project Scope Important	DEIS Chapter 2	2.2.2.2 Mine Site Road System	Pg. 2-42	*"The road system would include nine bridges, six of which would be single-span, two-lane bridges that range in length from approximately 30 to 125 feet. There would be three multi-span, two-lane bridges at Newhalen River (575 feet), Gibraltar River (470 feet), and Sid Larsen Creek (160 feet)."*	Twenty massive pieces of infrastructure are needed to begin mining: 3 new ports; 187 miles of LNG pipeline; 78 miles of new road; 3 multi-span bridges (525 ft., 470 ft. and 160 ft.); 1 or 2 lightering locations; 1 ice breaking ferry (tonnage not stated); 5 tailing embankments, each from 300 - 500 feet tall; 2 water treatment plants with 44 cfs total capability; 270-MW power plant; a camp for 1,700 people; two ice-breaking tugs, compressor station at Anchor Port; and finally build the largest ore processing plant in America. How is this financially possible for ore averaging 0.5% cuEQ? How will the applicant finance water treatment in perpetuity? What happens if gold and copper prices decline mid-project? As is required for FERC hydropower projects, USACE should require a financial statement of viability that proves the financing for the twenty infrastructure projects and water treatment in perpetuity actually exists. Until the finances are explained, NMFS will assume water treatment stops once the mine is no longer profitable and view the EFH assessment under that assumption. If the project proponent goes bankrupt mid project, NMFS is concerned that all EFH in the UTC, SFK and NFK will cease to exist and salmon will likely be extirpated from those three rivers.

Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Water Quality EFH Spills	DEIS Chapter 2	2.2.2.2. Transportation Corridor - Transportation Corridor Operations and Materials/ Personnel Transport	Pg. 2-59	*"Copper-gold concentrate would be loaded into specialized bulk cargo containers, each containing about 38 tons of concentrate, with removable locking lids."*	If the ferry carrying these 38-ton transport containers filled with copper/gold ore sinks to the bottom of Lake Iliamna, NMFS recommends USACE/project proponent explain how that event would affect Lake Iliamna's pH, metal concentrations in the lake water, and the juvenile salmon that rear there. Will metals accumulate in the Sockeye? If so, to what level? For how many decades will elevated metals be detectable in Sockeye? Will the juvenile fish with high metal concentrations in their tissues be able to smoltify and survive in the ocean? Will the adult sockeye salmon meet Food and Drug Administration (FDA) standards for human consumption? If some containers remained closed initially, how many months or years would it take to retrieve them?
Water Quality EFH Spills	DEIS Chapter 2	2.2.2.3 Amakdedori Port and Lightering Locations - Port Operations and Materials Transport	Pg. 2-69	*"Once inside the hold, the container lid would be opened, and the container turned upside down to unload the concentrate into the ship's hold. The container would be lowered as close as possible to the bottom of the hold to minimize the drop distance and the potential for dust generation during ship loading."*	Since the containers are 40 feet long, some ore would fall 50+ feet into the ship hull. After 20 years of dumping 38-ton sea containers into the belly of cargo ships at one lightering location, some fugitive dust will accumulate on the ocean floor. NMFS recommends USACE/project proponent explain how large an area of seafloor that dust will cover, what direction will it be predominantly carried by currents and how many acres of seafloor, if any, you expect to become sterile. Will the metals move up the food chain into EFH species? Which EFH species would be the most likely to be affected? Addtionally some ore will spill, as the sea at the main lightering location is known to be 6 - 12 feet, even on a good weather day.
Spills	DEIS Chapter 2	2.2.2.5 Action Alt 1. - Summer-Only Ferry Operations Variant	Pg. 2-78	*Action Alternative 1 – Summer-Only Ferry Operations Variant*	This makes it less likely to have spills in Lake Iliamna and more likely for leakage at the Amakdedori or other port storage facilities. NMFS recommends USACE/project proponent present a risk/consequences analysis to help all parties weigh the environmental risks.
Diamond Point with Ferry Alt	DEIS Chapter 2	2.2.3.3 Diamond Point Port and Llghtering Locations	Pg. 2-98 Fig 2-57	Diamond Point/Pile Bay/ Eagle Bay transportation route	This location, at the base of steep cliffs, looks prone to avalanches and rockfall and is within the river floodplain. NMFS requests USACE/project proponent explain how much ore will be present here on an average day and what would be the effects on the local environment if that spilled due to a rockslide. There are large steep barren areas just above the site on Google Earth and DEIS Fig 2-57; In wet portions of Alaska, only areas that slide frequently are barren. Alternatively, Diamond Point is a more naturally protected dock area and could lead to a safer lightering operation less likely to spill ore onto the shallow seafloor. NMFS recommends USACE/project proponent develop a risk/consequences analysis to help all parties weigh the environmental risks, and NMFS can weigh risk to EFH. NMFS is concerned that these important route decisions will be based solely on costs.
Diamond Point- only road Alt	DEIS Chapter 2	2.2.4 Action Alt. 3. - North Road Only	Pg. 2-106	No ferry; 82 miles of road:17 bridges; 3 multispan bridges (625, 245, 205'). 37 culverts at fish crossings. 8.8 million gallons fill for roads quarried from 26 sites. 121 million gallons water needed. NGL would follow road and 1 mile longer. 39 round trip truck trips.	This alternative removes the risk of a ferry full of ore sinking in Lake Iliamna and deserves careful consideration. NMFS recommends USACE/project proponent analyze the risks/consequences this alternative presents to EFH, both in the Lake Iliamna and in the streams the longer road must cross.
Alternative	DEIS 2	2.2.4.5 Alt 3 Concentrate Pipeline Variant - Transportation Corridor	Pg. 2-117	*"Construction of the concentrate pipeline adjacent to the north access road corridor would increase the road corridor width by less than 10 percent under most construction conditions. Construction of the concentrate pipeline and the optional return water pipeline would increase the average width of the road corridor by approximately 3 feet (PLP 2018-RFI 066). "* *"Daily truck traffic would be reduced to 18 round trips per day for transportation of molybdenum concentrate, fuel, reagents, and consumables (PLP 2018-RFI 065)."*	NMFS recommends USACE/project proponent include in the EFH Assessment how the EFH of species in Iniskin Bay might change due to this new 0.8 cfs source of non salt water which will likely contain elevated levels of metals and an abnormal pH. Four metals may start at 100 times the APDES permitted levels for discharge. Once a treatment plant removes these metals from the slurry, what will be the final fate of the metals?
Draft Environmental Impact Statement - Affected Environment - Chapter 3 - Groundwater					
Scope of Project	DEIS Chapter 3-13 Affected Environment Geology	3.13.4.1 Mine Site	Pg. 3.13-6 Table 3.13-1 and PLP 2018a	*"The proposed project would mine approximately 10 percent of the total estimated Pebble deposit resource."*	NMFS recommends USACE/project proponent explain why a mining entity that has already invested 1/2 billion dollars, and need to invest at least 10 times that in infrastructure before the first ore shipment leaves Alaska, would mine 10% of the estimated deposit and then suspend operations. Before USACE asks NMFS to review the Final EFH Assessement, please present a convincing argument that the project described in the EFH Assessment is what the USACE permit applicant plans to construct.

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Scope of Project	DEIS Chapter 3-13 Affected Environment Geology	3.13.4.1 Mine Site	Pg. 3.13-6 Table 3.13-1	"20-year Open Pit"	The Northern Dynasty plan was 25, 45 or 78-year mine life. The December 2017 USACE permit application, it says 16 years of operations. A year later the DEIS (December, 2018) says 20 years of actual mining. NMFS recommends USACE/project proponent give an accurate description of the entire mine footprint and timespan in the project description chapter of the EFH Assessment. It is not reasonable to ask NMFS to guess whether the USACE permit application, or the water rights application, or the DEIS is the correct project description. The EFH assessement should not spend 80% of the project description pages on the transportation cooridor, the LNG line, and a few ports, and only dedicate 3 - 4 pages describing the single project element that will affect EFH for centuries, the mine.
Groundwater Model	DEIS Chapter 3-13 Affected Environment Geology	3.13.4.1 Mine Site	Pg. 3.13-5 Fig 3.13-3	The mineralization that formed the Pebble deposit was likely caused by these diverse magma intrusions that comprise the rock in the open pit area (Knight Piésold et al. 2011a).	The same processes that make this pit ore rich (diverse magma intrusions) will make modeling water movement surrounding the pit difficult. Does the project proponent expect all magna types to respond to the removal pressure the same way? As pressure is removed by unburial, won't these different magna expand at slightly different rates and open up cracks? NMFS recommends USACE/project proponent analyze whether the contact zones between these diverse magma intrusions may open up and become a conduits for ground water movement. Until USACE/project proponent understands how far the pyritic mine water will move through the ground it is impossible to predict effects to EFH in the nearby streams.
Mine Description Groundwater Upwelling Extent of Impacts	DEIS Chapter 3-13 Affected Environment Geology Hamilton 2010	3.13.4.1 Mine Site	Pg. 3.13-3 Fig. 3.13-2	*"Unconsolidated sediments (overburden) cover a large portion of the mine site. These sediments consist of glacial till, outwash, alluvium, alluvial fan and deltaic deposits, and glaciolacustrine (glacial lake) deposits (Figure 3.13-2). Sediment grain sizes vary from silt, sands, and gravels to boulders. Overburden ranges in thickness from a few feet to about 165 feet."* Composition of the overburden material varies both laterally and with depth, typical of areas where material has been transported and deposited by both ice and water, with interbedding and gradations between types of material. (Hamilton 2010)	There is an understanding, based on the nature of hardrock mining, that eventually these tailings and the pit will become reactive in the presence of oxygen and water. Though that reaction starts slowly in different places, it gradually builds and increases over time eventually overwhelming water management systems that were designed to retain, control, mitigate and buffer the reaction. Mining operations in Alaska and the Northwest that process higher quality ores (lower stripping ratio), in regions with less seasonal precipitation and less ground and surface water interaction (drier regions with different geology), have exceeded permitted discharges of metals leaching from "waste rock facilities" (metals such as selenium, cadmium, chromium, lead and mercury, mobile disolved metals, etc). The applicant's operations plans basically says they will use the same methods and processes used by most other modern porphyry mining operations in the U.S. and Canada, except on a larger scale. This would suggest that sooner or later similar water quality issues will arise. NMFS recommends USACE/project proponent expand this section to explain how each of the water quality problems (pH, selenium, cadmium, chromium, lead and mercury, mobile disolved metals, etc) present in the Berkeley pit and other large porphyry mines will be avoided for Pebble. The project proponent needs to do better than slow down or delay the reactive process by submerging toxic tailings at the bottom of the mine pit lake. If they are only delaying the reactive process, this whole discussion is about when the SFK, NFK and UTC will become fishless, rather than if they will become fishless.
Water Quality Mine Description SFK Extent of Impacts	DEIS Chapter 3.13 Geology	3.13.4.1 Mine Site	Pg. 3.13-4 Fig. 3.13-2	*This figure shows a wide ancient 1- mile drainage channel (o2) flowing in a north to south direction, from just south of the pyritic TSF toward South Fork Koktuli.*	NMFS recommends USACE/project proponent explain how the ancient glacier outwash/drainage channel would interact with leakage from the pyritic tailing facility.

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Groundwater Model Extent of Impacts	DEIS Chapter 3.17 Groundwater Hydrology Ghaffari et. al 2011	3.17.1.2 Overview of Hydroecological Characterization of the Area	Pg. 3.17-16 Fig. 3.17-3 Ghaffari Fig. 18.1.5	*"Faults function as both conduits and barriers to groundwater flow." Pg. 3.17-16: "Deeper bedrock is both fractured and faulted, yielding areas of both enhanced permeability through fractures and reduced permeability where clay-rich fault gouge is present. Fault gouge is very fine crushed rock (e.g. clay-size) that results from friction caused by movement along a fault plane (between the two sides of a fault)." Fig. 18.1.5 of Ghaffari et.al 2011 shows ZG1 Fault clearly intersecting the mine pit.*	There are many faults and other geological features that affect the movement of water in the project area (Gillis 2009). Specifically, the ZG1 Fault bisects the pit on a southwest-to-northeast alignment (Ghaffari 2011, Fig. 18-1-5). In order to properly assess effects on EFH, NMFS needs a better idea of the movement of groundwater around the project area, especially through faults, fractures and joints. NMFS suggests the project proponent individually map and characterize all faults, fractures and joints in a 5 - mile radius of the open pit and how they will affect the movement of groundwater and acid mine drainage. Specifically, the proponent needs to demonstrate that acid mine drainage will not move along the ZG1 fault and end up in the groundwater. Rather than presenting generalized groundwater movement models from geometric mean hydraulic conductivities, the proponent should include the amount of water they expect each fault to transport each year and where that water might surface. This information, when properly combined in a model, will show where most of the acid drainage will likely be and at which elevation it will surface.
Climate Change	DEIS Chapter 3.16 Surface Water Hydrology	3.16.1.1 Mine Site Long Term Climate Change	Pg. 3.16-20	*"It is prudent to consider whether the use of historical streamflow and climate records, which are being used to evaluate the hydrology and impacts to hydrology (e.g., water balance, average monthly streamflow, and flood magnitude and frequency), are representative of conditions that may occur over the next several decades."*	The project proponent and USACE have recognized that storm intensity and length of droughts might increase in the future. NMFS recommends USACE/project proponent work with UAF climate modelers to use state-of-the-art, downscaled climate models to predict changes at the mine site over the next 40 years. By allowing the project proponent to correctly size their waste water storage and treatment facilities, this will minimize overflows of untreated water from the project and help to protect EFH.
Draft Environmental Impact Statement - Affected Environment - Chapter K3.17 - Groundwater Appendix					
Groundwater	DEIS Appendix K Chapter 3.17 Hydrology	3.17.6 Mine Site Groundwater Model	Pg. K3.17-32 Fig K3.17-13	This figure shows Lake Iliamna approx 90,000 feet from the pit.	When the pit reaches 1,900 feet deep it will be 900 feet farther into the earth than the Lake Iliamna surface. Water leaving Lake Iliamna would flow down a 900/90,000 or 1% slope to the pit if a flow path existed. The presented information is unclear whether there is a fracture perpendicular to the ZG1 fault line, but if there is such a fracture, water from the lake may slowly flow into the pit. Upon closure, when the pit is refilled to 890 feet a.m.s.l. of mine water laced with heavy metals will flow back towards the Lake Iliamna again on a 1% downward slope. It is the project proponents and the federal permitting agency's job to prove the substrate is 100% bedrock with low conductivity and no faults exist that would allow the mine tailing water to move into Lake Iliamna. So far the USACE/project proponent have suggested this will not happen, but that is not the same as proof. If, as the pit deepens and the applicants knowledge of faults/fratures increases, significant water bearing fractures are encountered, what action will be taken to protect the EFH in Lake Iliamna? NMFS recommends USACE/porject proponent present an adaptive management plan explaining how they will mitigate new fractures discovered during pit excavation.
Groundwater	DEIS Appendix K Chapter 3.17 Executive Summary	3.17 Groundwater Hydrology	Pg. K3-17-10 Table K3.17-1: Summary of Aquifers at Mine Site Pg. 3.17-16 Fig.3.17-3	*"Faults function as both conduits and barriers to groundwater flow" Table K3.17-3"Deeper bedrock is both fractured and faulted, yielding areas of both enhanced permeability through fractures and reduced permeability where clay-rich fault gouge is present." {DEIS Chapter 3.17.1.2). Figure 3.17-3 depicts 6 faults, but they may just be a generalized schematic. "Some faults act as flow barriers, while others appear as flow conduits, resulting in the potential for compartmentalized groundwater flow with the bedrock at depth" DEIS Executive Summary page 36*	NMFS recommends that USACE/project proponent map and characterize all faults, fractures and joints in a 5-mile radius of the 78-year open pit. At depth, these faults, fractures and joints will be the main conduits for moving groundwater and any errant acid mine drainage. NMFS recommends that in addition to presenting generalized groundwater movement models from the geometric mean hydraulic conductivities, include the amount of water you expect each fault to transport each year and where that water might surface. This information, when properly utilized in the groundwater model, will indicate in which drainage most of errant acid drainage will likely show up in and at which elevation it will surface. NMFS suggests tracer dye tests pumped down the bore holes might be an additional way to understand where the faults/fractures/joints move water.
Faults	DEIS Appendix K Chapter 3.17	K3.17.2 Aquifers and Confining Units	Pg. K3.17-13	*"Groundwater is controlled in the deeper bedrock by crosscutting fractures and faults. Although fractures and faults are widespread in the deep bedrock, the features are commonly infilled with fine-grained fault gouge1 that tends to block groundwater flow and are offset relative to one another (cross-cutting)."*	NMFS agrees that groundwater in bedrock is controlled by fractures and faults which are widespread. NMFS recommends the project proponent present the data that lead them to believe most are commonly infilled with fine-grained fault gouge? If even 10% are open and move water, how is that depicted in the groundwater model?

Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Groundwater Upwelling	DEIS Appendix K Chapter 3.17	K3.17.2 Aquifers and Confining Units	Pg. K3.17-14	*"During wetter periods, a higher number of deeper aquifers exhibit upward flow, reflecting groundwater discharge to a wider area of lowland waterbodies and wetlands."*	NMFS recommends the project proponent explain whether the deeper aquifers (greater than 500 feet) are exhibiting upward flow, or just the deeper sections of the overburden aquifer.
Aquifers	DEIS Appendix K Chapter 3.17	K3.17.2 Aquifers and Confining Units	Pg. K3.17-10 Table K3.17-1	*Table K3.17-1: Summary of Aquifers at Mine Site*	NMFS recommends the project proponent prepare a similar table for the aquifers in the deep bedrock stating what is known and what remains unknown. Its much simpler to believe there are zero deep aquifers, but your drill log data suggest there are a few, especially below 2,000 ft.
Groundwater Interbasin Water Transfers	DEIS Appendix K Chapter 3.17	K3.17.1 Groundwater Investigation Programs	Pg. K3.17-19	*The results of groundwater level monitoring and a water balance assessment (Schlumberger 2011a) suggests that approximately two-thirds of the groundwater flowing through the deep overburden aquifer downstream of Frying Pan Lake remains in the SFK River drainage, while the remaining one-third of the groundwater crosses the surface water drainage divide and contributes to base flow in tributary UT1.190, and discharges to UTC. Section 3.17, Groundwater Hydrology, Figure 3.17-10 depicts the divergent groundwater flow along SFK River to UTC in the deep groundwater aquifer. The divergent groundwater flow pattern occurs during seasonal low and high water periods.*	NMFS recommends the project proponent describe how they would stop this interbasin groundwater exchange, should the SFK groundwater quality start to deteriorate, due to water escaping from the pit or either tailings storage facility. Is it physically possible to stop a groundwater transfer happening at that scale?
Groundwater	DEIS Appendix K Chapter 3.17	K3.17.2 Aquifers and Confining Units	Pg. K3.17-19	*"The results of groundwater level monitoring and a water balance assessment (Schlumberger 2011a) suggests that approximately two-thirds of the groundwater flowing through the deep overburden aquifer downstream of Frying Pan Lake remains in the SFK River drainage, while the remaining one-third of the groundwater crosses the surface water drainage divide and contributes to base flow in tributary UT1.190, and discharges to UTC."*	This mine layout is an attempt to shift groundwater impacts east away from the UTC watershed and protect Lake Iliamna. The statement that "the remaining one-third of the groundwater crosses the surface water drainage divide and contributes to base flow in tributary UT1.19" shows that while the applicant may succeed some of the time, some mine contact water will end up in the the UTC! NMFS requests the project proponent describe what they would do if groundwater contamination starts showing up in the SFK to keep it out of the UTC watershed and Lake Iliamna. How long would that mitigation action need to continue?
Model Integration	DEIS Appendix K Chapter 3.17	K3.17.2 Aquifers and Confining Units	Pg. K3.17-20	*"site-wide water balance model (WBM) is 11 inches per year, the lowest rate of the three watersheds in the project area (groundwater recharge in the SFK watershed is estimated at 24 inches per year, and UTC watershed at 16 inches per year).*	Is the WBM the watershed model, the groundwater model or something else? Be consistent with the useage of "module" and "model" and the model names. NMFS recommends the project proponent explain how the 3 (or are there others) models function together.
Groundwater	DEIS Appendix K Chapter 3.17	K3.17.3 Aquifer Properties	Table K3.17-2 Pg. K3.17-21	*Summary of Hydraulic Conductivity Testing Results from Slug Tests*	Even a single hydrualic conductivity reading of 0.0014 m/s (which is 44 km/year) in the bedrock of the pebble deposit is alarming. It does not matter if the other 51 hydraulic conductivity results are all accurate and lower. If 2% or even 0.2% of the mine pit walls have this hydrualic conductivity, NMFS recommends the project proponent explain how do they plan to keep the AMD water in the pit from escaping.
Groundwater Model	DEIS Appendix K Chapter 3.17	K3.17.3 Aquifer Properties	Pg. K3.17-26	*"Larger-scale hydraulic conductivity values were also assessed by conducting nine pumping tests, and found that the hydraulic conductivity of overburden was almost 10 times higher than values derived from response tests (Schlumberger 2011a). Pumping rates ranged from approximately 10 to 356 gallons per minute (gpm); although seven of the nine tests reported well yields between 45 and 85 gpm. Water level responses were observed at monitoring wells located up to 760 feet away from the pumping wells, allowing for a more representative analysis of aquifer transmissivity (hydraulic conductivity) and storativity (specific yield) than is possible using response testing and packer testing alone."*	Pumping tests are a better way to measure hydraulic conductivity than slug or packer tests because the effects of impermeable well wall created by the drill bit are minimized. These pumping tests yeild 10 times higher values. NMFS recommends USACE/project proponent explain how the groundwater model includes these pump test derived values? There are far more slug and packer test values, but the data may be inaccurate. How did the models incorporate these different levels of data precision?
Draft Environmental Impact Statement - Chapter 4-17 - Environmental Consequences - Groundwater					

Topic	Document &	Section #	Page #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Ground Water	DEIS Chapter 4.17	4.17.1 Methodology for the Analysis of Groundwater Impacts	Pg. 4.17-2	*"or flow effects could be hydraulically connected to areas beyond the EIS analysis area."*	Once the pit extends deeper into the earth than Lake Iliamna and the Mulchatna River, the concept that those water bodies bracket the zone of effects may not hold true. While there are over 1 million linear feet of bore holes, the information about water flowpaths frorm holes deeper than 150 feet is sparse. In the horizontal slice of earth that passes through the lower third of the completed pit (sea level to 400 feet below sea Level), geographically bounded by Lake Illiamna to the Southwest, the Mulchata River to the North, and the Bristol Bay shoreline to the east, NMFS recommends the project proponent detail how many distince hydraulic conductivities were measured/estimated and the methods used.
Groundwater	DEIS Chapter 4.17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-6	*"It is expected that the amount of water produced during pit dewatering could be larger than simulated, and the capture zone and zone of influence could be larger. Additional details regarding model uncertainty are provided in the Appendix K4.17."*	If a specific dewatering design has not been developed, how can the capture zone be known or analyzed? To know the capture zone one needs to know number, locations and depth of dewatering wells, as these wells are what will "capture" the water. NMFS recommends the project proponent present a detailed dewatering plan with increased precision on the Northwest, West and Southwest sides of the pit where water will be captured from UTC and SFK watersheds.
Groundwater	DEIS Chapter 4-17 (Piteau Associates 2018a).	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-3	*"The magnitude and extent of impacts would be that groundwater levels would ultimately need to be lowered below the bottom of the final mine pit, which is estimated to be up to 2,200 feet below grade."*	This 2,200-foot depth is not the same as the depth stated in the DEIS project description (Dec, 2018) or in the USACE permit application (Dec, 2017). NMFS recommends USACE/project proponent explain why they plan to lower the water table 200 feet below the pit depth.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4-17.4 Fig. 4-17-1	*Conceptual Groundwater System Around Pit in Late Operations and Post-Closure*	During the estimated 20 years of refilling the pit (closure), tributary streams will be the most water stressed. Streams lose groundwater flowing towards the pit and there is little post-process water available to replace their lost groundwater. NMFS recommends the project proponent explain how they propose to keep the streams full during the refilling years. The bottom arrows appear to show lateral flow from the east (maybe) on the Late Operations diagram. Does that arrow represent flow coming 15 miles from Lake Iliamna DOWN the 1% gradient from the Ilimna Lake to the pit bottom during late operations? With the pit full of mine waste water to 890 feet a.m.s.l., the flow arrows should be away from it! NMFS requests the project proponent to explain their logic.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4-17.4 Fig. 4-17-1	*Conceptual Groundwater System Around Pit in Late Operations and Post-Closure*	If water seeps from Lake Iliamna to the pit and necessitates additional pumping, that will not be a major impact on Essential Fish Habitat. The adverse effect to Salmon EFH will commence once the pit is filled to 890 feet at closure +20 years, flow paths reverse, and acid mine drainage flows from the pit towards Lake Iliama or SFK drainage. Should this situation occur, the only way to protect EFH in Lake Iliamna would be to dewater the pit forever. This, however, would dry out streams and eliminate that fish habitat. Considering future earthquakes are unknown, and these earthquakes could open up fractures that do not currently exist, NMFS recommends USACE/project proponent present their plans to mitigate these possible future scenarios. Since this pit lake containing pyritic tailings exists in perpetuity, the region doesn't only have to go 100 years without new fractures developing, the Bristol Bay region needs to be earthquake free for 1,000+ years. NMFS recommends USACE/project proponents work with a geologist to understand earthquakes in the last 1000 years.
Groundwater Dewatering	DEIS Chapter 4-17 (Knight Piésold 2018e) (Piteau Associates 2018a)	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4-17.3 Piteau and Associates 2018a, pg 9	*"The initial dewatering well field during construction is conceptualized to consist of approximately 30 operating wells installed to a depth of 150 feet, and spaced about 200 feet apart around the starter pit perimeter (Knight Piésold 2018e). The wells would initially be pumped at a rate of 50 gallons per minute (gpm), with a total rate of approximately 1,500 gpm. The estimated groundwater inflow to the pit at the end of operations is estimated to be about 2,200 to 2,400 gpm (Piteau Associates 2018a)."*	Why are wells needed every 200 feet early in the operation, and then it is acceptable to move the spacing to 500 feet as the pit deepens? NMFS recommends the project proponent provide a plan for how many wells are operating when the mine is at 200, 600, 1200, 1900 feet deep, on what spacing, and how deep are the wells. Effects on EFH in a particular tributary basin cannot be determined if the amount of dewatering wells in the headwaters of those tributaries is not known.
Groundwater Faults Dewater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4-17.3	*"The well field at the end of mining is expected to include approximately 30 wells at 500-foot spacing around the pit perimeter."*	These wells are designed to just drain the overburden. NMFS recommends the project proponent explain how will they will intercept the flow along the ZG1 fault or the fractures connected to that fault.

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Climate Change	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4-17.3	*" Potential changes in future precipitation due to climate change that result in more rain and less snow would tend to even out swings in seasonal recharge to the groundwater system ...(AECOM 2018)"*	This is based on an assumption that snowstorms change to rain but total annual precip stays the same. A warmer Bering Sea/Gulf of Alaska will produce stronger wind and 12 months of ice free time each year, leading to more intense storms delivering higher 24-hour maximum precipitation events. NMFS request USACE/project proponent work with climate scientist at UAF to understand these storms, and design mine facilities to accommodate these higher rainfall totals.
Habitat Loss	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-5	*"In terms of magnitude and extent, some wetlands, stream segments, ponds, or lakes in the immediate pit area may be eliminated as the water table is lowered, and water leaks out of these water bodies during construction and mining operation."*	Until the project proponent states which wetlands, streams segments, ponds and lakes will be eliminated and if they were EFH before exploratory drilling began, no one can predict the mine's effects on EFH. Many of those water bodies currently provide rearing habitat for salmon. Others likely did provide rearing habitat, but now may be contaminated by leaking boreholes. NMFS recommends USACE/project proponent provide a level of information about juvenile fish distribution that will allow their EFH Assessment to be accurate.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-5	*"The extent of impacts is that pit dewatering may locally impact groundwater flow across the groundwater divide, drawing groundwater from the headwaters of the UTC watershed depending on the extent of the cone of depression around the pit (Piteau Associates 2018a)."*	This statement undermines the PLP claim that EFH in the UTC tributary reaches will not be affected. NMFS recommends USACE/project proponent clearly state: 1) How much EFH exists in the UTC tributaries; 2) How many tributary miles will be affected by these dewatering wells; 3) What months of the year will the effects be most detrimental to EFH.
EFH	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-5	*"Impacts to wetlands, ponds and small streams located upstream of the WTP discharge location would not be mitigated by the WTP discharges."*	NMFS recommends the project proponent provide a map of every water body upstream of the WTP which may go dry and would not be mitigated so the project proponent can determine how much EFH will be lost.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering Piteau Associates (2018a)	Pg. 4.17-8	*"Piteau Associates (2018a) estimates that the cone of depression at its widest extent at the end of operations would range from a distance of approximately 1,500 feet from the pit crest along its northeastern side, to as much as 14,000 feet along the ridge southeast of the pit, depending on the actual hydraulic characteristics of the affected aquifer (Figure 4.17-3)."*	2.8 miles of the cone of depression on the southeast will be split between the SFK and UTC watersheds. However wide the cone of depression is, the "zone of influence" is even wider (See Piteau 2018a). NMFS recommends the project proponent explain how a cone of depression extending 2.8 miles into UTC can fail to affect any UTC streams or EFH in the UTC watershed? Sean is here- noon
Site Closure EFH	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-8	*"This would result in a permanent pit lake that would be pumped to maintain the MM level indefinitely (allowing for 10 feet of freeboard to accommodate the probable maximum flood and still not breach the not-to-exceed level of 900 feet)."*	Indefinite pumping of a toxic pit lake upstream of Lake Iliamna salmon habitat is a problimatic environmental closure. NMFS recommends the project proponent either develop a different closure strategy, such as locking up the toxic tailings in a paste and eliminating the need for the lake, OR state that EFH in many miles of the UTC and SFK will be either severely impaired or completely destroyed within the next 100 years. The project proponent thinks it will take a long time for these extremely destructive impacts to take hold. This idea of a toxic lake pit slowly becoming diluted and inert isn't working at the Berkeley Pit in Montana, which was closed in 1982, and it will not work in the Bristol Bay Watersheds.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-8 Fig. 4.17-3	*Piteau Associates (2018a) estimates that the extent of the post-closure cone of depression would range from a distance of about 1,500 feet from the pit crest along its northeastern side, to as much as 13,500 feet from the pit crest to the southeast, depending on the actual hydraulic characteristics of the affected aquifer (Figure 4.17-3).*	NMFS recommends the project proponent explain why the 50th percentile lines do not fall at intermediate spots between the 5th and 95th percentile lines. NMFS request a clearer presentation of what these percentiles actually represent. The lines are so similar on so many sides of the mine, it appears the model that produces them is not very precise.
Groundwater	DEIS Chapter 4-17	4.17.3.1 Mine Site - Pit Dewatering	Pg. 4.17-10	*"The estimated extent of the capture zone in post-closure would be about 1,800 acres."*	NMFS recommends the project proponent present a complete dewatering plan before stating a single number for the capture zone. Also please present a range of values for the capture zone for the 78-year pit.
Tailings	DEIS Chapter 4.17	4.17.3.1 Mine Site - Tailings Storage Facilities - Bulk TSF	Pg. 4.17-14	*"With the exception of the upstream face of the bulk TSF south embankment, which would be lined with HDPE, the bulk TSF would be unlined, and the bulk TSF main embankment would operate as a flow-through structure draining towards the north (see Section 4.15, Geohazards)."*	NMFS recommends the project proponent present information on similar large mines that let a 500 ft tall embankment flow through and where it stood without issues for decades. If it has not been done before, NMFS requests USACE not allow the Koktuli watershed to be used as a test case for this massive flow-through structure.
Tailings	DEIS Chapter 4.17	4.17.3.1 Mine Site - Tailings Storage Facility - Bulk TSF	Pg. 4.17-14	*"Construction of the bulk TSF would locally impact surface water features at the site, and potentially impact groundwater/surface water interactions; this impact is expected to be modest in extent (e.g., approximately 8,000 acres [PLP 2019-RFI109b] near the vicinity of the bulk TSF), but permanent."*	NMFS recommends the project proponent explain the effects of the TSF in the first 20 - 30 years, as this relatively dry tailings material spread over 2.5 quare miles manages to absorb, rather than convey, much of the rainwater. Wouldn't this tend to dry out the surrounding tributary streams as they are deprived of this rainwater?

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Project Scope Extent of Impacts	DEIS Chapter 4.17	4.17.7 Cumulative Effects	Pg. 4.17-25	*"Pebble Project buildout—development of 55 percent of resource over a 78-year period."*	The entirety of the environmental review appears based on the 20-year mine plan. Instances like this that discuss the 78-year plan represent a lot of uncertainty for NMFS as to the adequacy of the EFH Asssessment. NMFS recommends a thorough environmental review of the 78-year mine plan.
Project Scope	DEIS Chapter 4.17	4.17.7.2 Reasonably Foreseeable Future Actions - Alt 1 - Applicant's Proposed Alternative	Pg. 4.17-26	*"Pebble Mine Expanded Development Scenario. An expanded development scenario for this project, as detailed in Table 4.1-2, would include an additional 58 years of mining and 20 years of additional milling over a substantially larger mine site footprint, and would include increases in port and transportation corridor infrastructure under Alternative 1. The Pebble Project expansion would result in additional development not included under the other alternatives..."*	NMFS recommends the project proponent evaluate the expanded development scenario in both the their EIS and EFH Assessment.
Project Description	DEIS Chapter 4.17	4.17.7.2 Reasonably Foreseeable Future Actions - Alt 1 - Applicant's Proposed Alternative	Pg. 4.17-26	*"The buildout would correspond to about a six-fold increase in the footprint of the pit, an increase in pit depth to about 3,500 feet (PLP 2018-RFI 094), and a duration increase of up to 78 years for the operations capture zone."*	NMFS recommends the USACE/project proponent explain how many of the additional five square miles of pit development will happen in the Upper Talaric Creek Watershed.
Project Scope Extent of Impacts SFK UTC	DEIS Chapter 4.17	4.17.7.2 Reasonably Foreseeable Future Actions - Alt 1 - Applicant's Proposed Alternative	Pg. 4.17-26	*"the estimated capture zone for the expanded dewatered pit during operations would be an irregular circle about 5 miles across (about 20 square miles) straddling the SFK and UTC drainages, although it could extend 1 to 2 miles further south along the ridge between these watersheds, if similar to the modeled capture zone under Alternative 1 (Figure 4.17-2)."*	In the groundwater sections of the D-EIS, PLP has implied that very little water moves below the overburden zone. If this is true, NMFS requests the project proponent answers the following questions: 1) Why does a 5 square mile pit have a 20 square mile capture zone? 2) How much bigger does the entire mine footprint become? 3) How much of the capture zone is actually underneath tailing storage facilities?
Site Closure Groundwater	DEIS Chapter 4.17	4.17.7.2 Reasonably Foreseeable Future Actions - Alt 1 - Applicant's Proposed Alternative	Pg. 4.17-26	*"It is estimated that the expanded pit would draw about five times more groundwater than under Alternative 1; or about 12,000 gpm (27 cfs) near the end of operations and 6,500 gpm (15 cfs) in post-closure. About half of this inflow would come from the SFK watershed and half from UTC.*	NMFS recommends the USACE/project proponent explain how they came to this conclusion. It seems like the number should not be as simple as a 5 times larger hole draws down 5 times the water.
Project Scope Extent of Impacts Groundwater	DEIS Chapter 4.17	4.17.7.2 Reasonably Foreseeable Future Actions - Alt 1 - Applicant's Proposed Alternative	Pg. 4.17-27	*"The potential for impacts on shallow groundwater interception along the transportation and pipeline corridors would increase under the expanded mine scenario, because both the north and south access corridors would be used, and the north corridor would eventually be wider and longer to accommodate a diesel pipeline."*	There is no description or mention of construction of a diesel pipeline or expansion of road access in any of the Project Description or Purpose/Need documents. NMFS recomends the USACE/project proponent provide full descriptions and environmental reviews of these components if they are a planned part of this project's future.
Draft Environmental Impact Statement - Chapter K4-17-Groundwater Appendix					
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.1 Model Development, Calibration, Input Scenarios, and Uncertanity	Pg. K4.17-1	*"Miscellaneous information about the 2018 model detailing layers, boundary conditions, input parameters, and calibration results are available (PLP 2018- RFI 019c; Knight Piésold 2018n; PLP 2019-RFI 109, 109a, 109b, and 109c); however, the model is 'still in the process of being updated and is not fully calibrated' (PLP 2019-RFI 109)."*	NMFS understands that no model is perfect, but NMFS does not feel a 10-layer model that lacks a calibration report and has not been validated is reliable enough to be the basis for an EFH Assessement. Groundwater upwelling is the unique attribute making this prime spawning area and the mine's effect on upwelling are not yet understood. NMFS recommends the project proponent calibrate and validate their model using distinct data sets, then run it for the two pit sizes, and then start their EFH assessment. While there is abundant information on the upper model layers, NMFS suspects the project proponent needs to collect more information on the hydraulic conductivity of the lower stratum.

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Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.1 Model Development, Calibration, Input Scenarios, and Uncertainty	Pg. K4.17-1	*"Knight Piésold (2018n: Figures 10 and 11, and Table 1) provides the range of hydraulic conductivity and storage values between the 5th and 95th percentile realizations for model layers and zones used in the pit capture zone analysis (shown on Knight Piésold 2018n: Figures 1 through to 7)."*	The current capture zone predictions and mine contact water spread predictions are based on a 10-level groundwater that has not been calibrated (PLP 2019-RFI 109). For the 20-year mine scenario, NMFS cannot reliably determine where EFH will be compromised because upwelling stops without a finalized, calibrated, validated groundwater model. For the 45 or 78 year mine, the model does not have enough information to predict what happens at depth. Fewer than 1/2 dozen bore holes penetrated deeper than 2,500 feet (or at least they're not publically available). The few that extend below 2,500 ft. present confusing layers, some of which indicate permeablility. In a non volcanic area without faults, bedrock generally becomes less permeable at depth. The little data that exists below 2000 feet indicates strangely high hydraulic conductivity layers down deep (Schlumberger 2015a, 2011a) This area was a subduction zone, so unusual findings are not neccessarily wrong; however, digging a pit into this unknown could easily compromise Lake Illiamna and the Kivachik River sockeye run. NMFS recommends the project proponent collect and present a much more detailed study of the geology and hydraulic conductivity below 2,000 feet of depth.
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.1 Model Development, Calibration, Input Scenarios, and Uncertainty	Pg. K4.17-1 to K4.17-2	*"The value of hydraulic conductivity used for layer 4 in the pit area is lower than mean values of hydraulic conductivity determined from response and pump tests in bedrock by about an order of magnitude (Schlumberger 2015a: Tables 8.1-1 through 8.1-6, and Appendix K3.17, Figure K3.17-14). "* *"Larger-scale hydraulic conductivity values were also assessed by conducting nine pumping tests, and found that the hydraulic conductivity of overburden was almost 10 times higher than values derived from response tests (Schlumberger 2011a)."*	NMFS recommends the USACE/project proponent present the logic by which the hydraulic conductivity for layer 4 was lowered by an order of magnitude in the model.
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.1 Model Development, Calibration, Input Scenarios, and Uncertainty	Pg. K4.17-2	*"Hydraulic conductivity values assigned to deeper bedrock (Knight Piésold 2018n; layers 5-10) appear to be an order of magnitude or more lower than field-measured values (Section 3.17, Groundwater Hydrology, Figure 3.17-7 through Figure 3.17-9, and Appendix K3.17, Figure K3.17-14). Pebble Limited Partnership (PLP) (2019-RFI 109c) noted that the low hydraulic conductivity values used in the model were needed to achieve an adequate calibration, and that field and literature evidence suggests that bulk bedrock values may be lower than indicated by field tests."*	This discrepancy between literature-predicted values and field-measured values is possibly caused by a system of fractures and joints not recognized by the model moving the water around, even though the individual stratum seems to have low hydraulic conductivity values. The DEIS's' suggestion that the field test gave an atypically high HC value is unlikely. The drill head sometimes clogs porous matrix along the borehole wall lowering, but not raising, measured hydraulic conductivities. This can lead to HC values that are much lower than actual. NMFS recommends the EIS use actual observed field data rather than theoretical numbers in the models.
Groundwater Model Watershed Model	DEIS Appendix K Chapter 4-17	K4.17.1 Model Development, Calibration, Input Scenarios, and Uncertainty	Pg. K4.17-2	*"Recharge rates assigned to the groundwater model were the average rates generated by the watershed module (Schlumberger 2011a), which take climate variability into consideration by incorporating long-term precipitation data for the study area (Knight Piésold 2018a)"*	NMFS recommends the EIS run the watershed model with at least 3 "wet" years in a row (average 140% of mean precipitation per year), which is becoming more probable. NMFS appreciates that the project proponent "bootstrapped" in climate variability. Variability is important, but a different process than awknowledging that the climate is changing and is likely to get wetter.
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.2.1 Operations	Pg. K4.17-2	*"Travel time from the outlying areas to the pit associated with the 95th percentile capture zone averages about 80 years, and would likely be longer because the model assumes that the pit is instantaneously full-size at the start of operations."*	The capture zone explained in the document averages less than 1 mile wide, and the overburden has decently high hydraulic conductivities. NMFS recommends the EIS explain why it projected an 80-year travel time.
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.2.1 Operations	Pg. K4.17-2 to K4.17-3	*"Groundwater between the immediate pit capture zone and the outlying ridge areas is predicted to discharge to local streams or seeps as they do currently, and not be affected by the capture zone (Piteau Associates 2018a; Knight Piésold 2018n)."*	If there are both contiguous and discontiguous areas of groundwater effect from the cone of depression, doesn't that indicate the model is relying on some deep connection between the two locations? While that is possible, it is difficult to believe seeps between the two areas are completely unaffected. If the seeps are affected, the local EFH would be affected. NMFS recommends that the EIS evaluate the effect of reduced groundwater discharge on these seeps ajacent to the outllying ridge.
Groundwater Model	DEIS Appendix K Chapter 4-17	K4.17.2.1 Operations	Pg. K4-17-3	*"Similarly, the model predicts that the rates of groundwater inflow to the pit would be within a relatively narrow range of 2,200 to 2,400 gallons per minute for the 5th to 95th percentile scenarios, respectively (Piteau Associates 2018a). These similar model outcomes may reflect a lack of robustness in the Monte Carlo analysis."*	NMFS agrees that something is amiss with the model if the range of outcomes is 2,200 to 2,400 gallons/minute (4.9-5.3 c.f.s.). Considering variable precipitation and unknown storage capacity, the range should be larger. If the model is not credible, the EFH Assessment that relies on it will also be inaccurate.

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Groundwater UTC	DEIS Appendix K Chapter 4-17	K4.17.2.1 Operations	Pg. K4.17-3 Fig. K4.17-2	*"The reduction in groundwater discharge to the headwaters of UTC was analyzed by the model scenarios for late winter months January-March using a transient model simulation at dynamic equilibrium (Piteau Associates 2018a). Without the addition of water treatment plant (WTP) outflows, groundwater discharge to the upper UTC drainage is predicted to decline 14 to 19 percent at the end of operations for the 5th to 95th percentile model scenarios, respectively (Figure K4.17-2)."*	NMFS recommends the EIS explain why there is only a difference of 5% in groundwater percent between very wet assumptions and very dry assumptions. On the UTC mainstem, this could be correct because 2/3 of groundwater could come from the North and East. For UT146A and other tributaries this seems unlikely.
Site Closure Groundwater	DEIS Appendix K Chapter 4-17	K4.17.2.1 Operations	Fig. K4.17-1c	The figure *Simulated Drawdown Contours at End of Operations For the Pit Area Model* indicates that there will be a significant amount of drawdown in the UTC drainage at the end of operations.	With the amount of drawdown shown in K4.17-1c, effects on juvenile EFH at least in closest 1/2 mile to the pit in the UTC drainage are unavoidable. Additionally, there appears to be 5 - 9 miles of tributary stream that will disappear in SFK. NMFS recommends the project proponent reassess how much EFH exists in these small tributaries close to the pit.
Groundwater	DEIS Appendix K Chapter 4-17	K4.17.2.2 Closure	Pg. K4.17-8	*"The exception to these measurements is that three water-level measuring ports between depths of 3,800 and 4,000 feet exhibited heads between 25 and 35.7 feet below land surface between 2009 and 2012."*	This observation may indicate a confined aquifer in that deep stratum. If it was solid bedrock, it seems there would be no head at all. NMFS recommends the EIS include an investigation of the deepest stratum to confirm the presence or absence of such a deep aquifer.
Site Closure Groundwater	DEIS Appendix K Chapter 4-17	K4.17.2.2 Closure	Pg. K4.17-8	*"The long-term steady-state average annual groundwater inflow to the pit in post-closure is estimated to be about 1,300 gallons per minute (about 3 cubic feet per second [cfs]) (Piteau Associates 2018a)"*	In order to accurately assess the post-closure pit's effect on EFH, NMFS recommends the EIS provide the leak rate of the pit; NMFS acknowledges that the pit walls below 890 feet are not completely leakproof. Perimeter drawdown wells could capture leakage in the top 200 feet, but NMFS recommends the EIS describe how they intend to mitigate the potential for water to slowly travel down a fault line, away from the pit, at depths deeper than 200 feet. Even deep dewatering wells on 50' spacing could fail to intersect the fault.
Site Closure Groundwater	DEIS Appendix K Chapter 4-17	K4.17.2.2 Closure	Pg. K4.17-8	*"This means that the deeper groundwater levels had a higher head than the lake would have, and that deep groundwater below the pit bottom would flow upwards toward the bottom of the lake."*	NMFS recommends that the EIS provide an illustration and the data that supports this logic. How many times did the project proponent measure "heads" in boreholes with depths similar to the pit's final depth?
PERMIT APPLICATION (POA_2017-271) ATTACHMENT D - Dec 2017 / D-EIS ATTACHMENT B – Dec 2018 / APPENDIX N - Feb 2019					
Climate Change	Appendix N, Project Description Dec 2018	4.1.3.1 Water Management Plan	Pg. 57	*"The accuracy of water balance models is limited by many factors, including the stochastic nature of the inputs and the potential effects of climate change" [(Dec 2017, Page 62, Section 4.1.3.1), (Dec 2018 and Feb 2019, Page 57, Section 4.1.3.1)].*	For a mine projected to last 25 to 78 years, simply stating that climate change may effect water influx (precipitation) is not acceptable. Not planning for the future will make the project proponent unable to protect the fresh water the fish depend on, and the pumping costs could affect the entire bottom line of the project. NMFS recommends the project proponent work with climate scientists at UAF to get the best climate predictions possible for this region.
Groundwater	Department of the Army Permit Application POA-2017-271	Attachment D Project Description	Pg. 58 Fig.4-1, Pg. 65	*"All runoff water contacting the facilities at the mine site and water pumped from the open pit will be captured to protect the overall downstream water quality. The ultimate Project design will incorporate a detailed analysis of water collection and management, including quantity and quality estimates, water treatment options, water management facility design, and strategic discharge of treated water. The water management plan will enable the plant to operate without requiring additional water from off-site sources. Mine site water management systems will be designed for the entire life cycle of the Project, from initial construction through the preproduction phase, operation, and closure."*	Does the EIS assume underground water flow paths originate entirely within the project area? The characteristics of the water moving through this matrix, and the matirx's permeability, unconsolidated nature and interconnectedness suggests it is highly probable some water is originating outside the EIS analysis and flowing through the area. Water withdraws and drawdown will disrupt long established flow paths with very uncertain impacts on the water quality in the supporting and surrounding aquifers and the EFH attributes salmon rely on to support survival. NMFS recommends the EIS describe water flow into/out of the groundwater flow model, perhaps from the Mulchata River to the north or from Lake Clark to the northeast. This is especially important in the deeper strata as we agree the overburden and most shallow layer or two of bedrock are probably under local hydrologic control. At this point, it is difficult to ascertain the spatial and three-dimensional extent of multiple cone/s of depression created by the barrier wells that will result from project operation (only pit dimensions are provided).

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Project Description	Appendix N, Project Description Dec 2018 Department of the Army Permit Application POA-2017-271	1.1 Pebble Summary Information Attachment D Project Description	Pg. 1 Pg. 1	*Appendix N: "Final pit dimensions of 6,800 feet in length, 5,600 feet in width, and 1,970 feet in depth. Attachment D: "Final pit dimensions of 6,500 feet in length, 5,500 feet in width, and 1,350 to 1,750 feet in depth."*	NMFS recommends USACE clear up the discrepancies between the size of the pit detailed in the Permit Application vs. the DEIS. While the variance in width is minor, the depth matters.
Groundwater Water quality	Appendix N Project Description Dec 2018	3.4.4.2 Pyritic TSF	Pg. 40	*"The embankments will be constructed using select borrow materials and include a liner bedding layer, overlain by a liner, on the upstream slope and over the entire internal basin."*	NMFS questions whether the liner will be 100% impermeable as most mine operators predict a certain number of holes per square meter and then use that in conjunction with head to predict how much mine water will escape. NMFS recommends the EIS establish a linear leakage coefficient, based on other pond liners in other large mines. While leakage is often stated as volume/day/square meter of liner, larger liners actually leak more per unit area, as seams that are sealed in the field are weak links. If the mine expansion plan is implemented in 2045, how will the pyritic tailing lining, now sitting under a hundred feet of pyritic tailings, be repaired or replaced? Will the project proponent install a liner with a 78-year lifespan at the start? Does such a liner exist? An area as rich in salmon habitat as the Koktuli Watershed, should not be used as a test case for a type of liner that has never undergone long-term testing. NMFS recommends the EIS provide an estimate of the leakage on the oldest liner currently in use below an existing pyritic tailings pile.
Water Management Plan Dewatering Wells	Department of the Army Permit Application POA-2017-271	Attachment D Project Description	Pg. 58	*"A primary design consideration is to ensure that all contact water that requires treatment prior to release to the environment will be effectively managed." "The ultimate Project design will incorporate a detailed analysis of water collection and management, including quantity and quality estimates, water treatment options, water management facility design, and strategic discharge of treated water."*	The discussion of pit water management has to extend beyond treatment of water for contaminants to meet standards. Discharging water that meets treatment standards will still alter EFH attributes and subsequently impact fisheries. An open-pit mine operation at this depth with this level of connected groundwater hydrology disrupts local groundwater flow systems with consequences beyond local hydrology (flow variability) and water quality parameters (e.g. water temperature and constituents). Changing receiving waters (gaining reaches) from upwelling zones to downwelling zones essentially changes one of the fundamental EFH attributes that support these salmon populations. Maintaining instream flows does not similarly represent duplicating upwelling ground water. Water management should include discharging water at the appropriate temperature, at the natural levels of dissolved constituents as the baseline condition, which in this case is nearly pristine water, in order to avoid impacts to habitat. Water should also be discharged in a pattern that aquatic resources such as resident fish, invertebrates, and anadromous species are adapted to. Fish migration, spawning, incubation, and rearing are highly sensitive to water temperature (Maclean 2003). Site-specific thermal patterns are also known to drive population diversification and genetic diversity, meaning that populations are highly adapted to the patterns with which they have evolved.There is no way to predict how salmon will respond to the changes that the Pebble Mine will cause. NMFS recommends the EIS demonstrate how the project intends to maintain each key salmon EFH attribute both during active mining and at closure.

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Water Management Plan Dewatering Wells	Appendix N Project Description Dec 2018 Heath 1983 Alley et. al 1999	4.1.2.1 Water Management Plan	Pg. 55	*"Preproduction Phase mining cannot commence until the water table in the open pit area has been lowered by groundwater pumping. The open pit dewatering system will be installed prior to Preproduction Phase mining to provide sufficient time to draw down the water table in the area. This will allow uninterrupted overburden removal in preparation for production mining of mineralized material. A series of dewatering wells will be drilled into and around the perimeter of the open pit, with the exact well number and location determined by testing the overburden aquifers. The number of wells will include an allowance for wells with poor or no water yields and wells lost through sanding, equipment loss, or other interference with water production. Pump sizes for each well will be based on well-specific yields (Barrier Wells). Water will be discharged to the environment if it meets water quality criteria; otherwise, it will be treated in a modular water treatment plant prior to discharge."*	Soon after pumping begins, all water pumped by the wells is derived from water released from groundwater storage. As the cone(s) of depression expands outward from the well, the well begins to capture groundwater that would otherwise have discharged to the stream. In some circumstances, the pumping rate of the well may be large enough to change water course, causing water to flow from the tributary stream to the aquifer, a process called induced infiltration of streamflow. Streamflow depletion is equal to the sum of captured groundwater discharge and induced infiltration (modified from Heath, 1983; Alley and others, 1999). The project will end up dewatering much of the project area, while simultaneously attempting to reintroduce water as a downwelling source, covering greater surface area and depths as the project expands by using barrier wells. This is a drastic change of water quality and flow in and area of known salmon habitat. Given salmon's dependence on the complex network of ground and surface water regimes currently in the project area, NMFS recommends the EIS describe how the project intends to not only reintroduce water back to the environment, but introduce water with the same quality and other EFH attributes necessary for salmon to live and spawn.
Water Management Plan Groundwater Model EFH Attribute (problems with predictions of PHABSIM model)	Appendix N, Project Description Dec 2018 Waddle 2001 Maclean 2003 Mouw et. al 2014	4.1.3.1 Water Management Plan	Pg. 57-63	*"Treated water discharge will be distributed to these locations in a manner that best optimizes downstream aquatic habitat conditions. Optimal conditions will be determined using a Physical Habitat Simulation System (PHABSIM) habitat instream-flow model and in accordance with ADEC and Alaska Department of Fish and Game (ADF&G) permit conditions."*	There are some assumptions and conclusions suggested that the instream-flow model was not designed to support. According to the User Manual for PHABSIM (Waddle 2001), PHABSIM does not account for the action of upwelling waters in spawning and redd site selection. The key EFH attribute that makes this area so salmon productive is the extensive network of highly interactive ground and surface water regimes. Salmon have evolved incubation strategies that are linked with groundwater thermal patterns, so they cue in on upwelling water. Salmon are also strongly influenced by vertical hydraulic gradient, tending to select spawning sites where groundwater is upwelling into the streambed or advected through the streambed. These EFH characteristics are well documented to be very important in driving habitat selection and life history diversification (see Maclean 2003, Mouw et. al 2014). PHABSIM models were not developed to account for these important influences. PHABSIM requires site-specific flow hydraulics, namely flow velocity (see discussions below), to be the primary driver of the selection of rearing and spawning habitat. When this isn't the case, PHABSIM is not an appropriate instream-flow analytical framework (Waddle 2001). The presence of water is a key EFH attribute to salmon freshwater survival. PLP studies have not identified the most critical physical EFH attributes to salmon survival. If the influence of groundwater regimes driving upwelling hyporheic flows is the key EFH attributes to downstream populations, then the PHABSIM models are irrelevant to the assessment of impacts on EFH. NMFS recommends the project proponent switch from the PHABSIMs model to a different model that is better suited to a system dominated by groundwater upwelling.
Water Quality Extent of Impacts Groundwater Model Watershed Model	Appendix N, Project Description Dec 2018	4.1.3.1 Water Management Plan	Pg. 58	*"Water collection, management, and transfer will be accomplished through a system of water management channels, ponds, and pump and pipeline configurations. These systems will be designed to handle the large flows that occur during spring freshet and late summer/fall rains." "Leak detection systems that report to a central control system will be employed, as will monitoring systems to control pump cycling, high and low water-level switches, no-flow (or low-flow) alarms, vibration overheating alarms, and other systems as appropriate to monitor water management systems."*	PHABSIM models were developed to predict impacts in terms of water quantity in the main channel. It ignores impacts to all other wetlands and rearing channel types. There is no reference, summary, or discussion of the proposed PHABSIM model or the adequacy of this approach. There is no reference to supporting materials. It is doubtful that impacts to habitat could be comprehensively evaluated as a function of water quantity while ignoring water quality (e.g. water temperature) and other physical attributes and aspects of the habitat. The D-EIS does describe the proposal of engineered drainage networks, but does not address the likely potential for others to develop on their own, especially if the materials are natural. These issues are a concern because the surrounding overburden aquifers are highly connected, unconfined, and support high levels of dissolved oxygen. This leads to concerns over water quality and potential discharge of contaminated groundwaters into surface waters. NMFS advises project proponent to evaluate more thoroughly predictions of water quality in streams as a result of project, with careful considerations to the above physical attributes of this ecosystem.

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Water Quality Mine Description Surface Water Extent of Impacts	Appendix N Project Description Dec 2018	4.1.3.2 Water Treatment	Pg. 60	*"Reject from the nanofiltration (NF) membranes [in the Main Water Treatment Plant] will have a high concentration of dissolved sulfate and other divalent ions. To prevent overloading the mine water balance with dissolved sulfate, sulfate must be precipitated from the reject before transferring to the pyritic TSF. Sulfate from the NF reject will be precipitated as calcium sulfate with a lime softening process. The calcium sulfate sludge will be transferred to the pyritic TSF. Based on the expected pH in the pyritic TSF, the calcium sulfate sludge is not expected to re-dissolve."*	Main Water Treatment Plant (WTP#2) step 5 discusses the placement of the precipitated calcium sulfate solids into the pyritic TSF and notes that modeling indicates that the conditions in this TSF should prevent redissolution of the solids. Mining operations in Alaska and the Northwest that process higher quality ores in regions with less seasonal precipitation and less ground and surface water interaction than this project have exceeded permitted discharges of metals (TDS) leaching from waste rock facilities. At least one other mine in Alaska has issues with TDS chemistry where the conditions indicate that precipitate should form but hasn't. Excess discharge of TDS is typically the result of: 1) models that predict metals can be removed in precipitates, when metals actually remain in solution, 2) project proponents do not properly construct or install equipment or institute protective measures in the manner that is detailed in their Environmental Impact Statement, and/or 3) operating treatment systems are overwhelmed by surpluses of water from multiple sources. While modeling might show that these solids won't be dissolved, NMFS recommends that the USACE/project proponent have a contingency plan detailing how this issue would be handled.
Water Use and Mangement	Surface Water Right Applications dated July 7, 2006 http://dnr.alaska.gov/mlw/mining/largemine/pebble/water-right-apps/2006/gwutfinal.pdf	Water Rights Applications		*Upper Talarik Creek. "The current maximum proposed extension of an open pit to mine the West Zone of the Pebble surface deposit extends approximately 3,000 feet into the Upper Talarik Creek drainage …. The company estimates that such a diversion would, on average, decrease the monthly flows of the creek at the USGS flow station* **12 miles downstrea**m by between 6% and 9%, depending on the month. The percentage decrease would be smaller further downstream." (LAS 25876) South Fork Koktuli. "The company estimates that such a diversion would, on average, decrease the monthly flows in the South Fork Koktuli River by 15% to 16% approximately **10 miles downstream** at the USGS flow station (below the area where the stream dries up in the summer)." (LAS 25874) North Fork Koktuli. "They estimate that this impoundment would reduce the flow of the North Fork Koktuli River by 8% at the USGS flow station approximately **14 miles downstream**." (LAS 25871)	The Surface Water Rights Applications suggest instream flows will be reduced several miles downstream of the mine site (UTC 12 miles, SFK 10 miles, NFK 14 miles) as a result of groundwater withdraw from underneath the watersheds. The percent of decrease in the instream flows will increase with closer proximity to the mine site and de-watering wells. This increased range of impact is not represented in the EFH Assessment and do not support the conclusions in the EFH Assessment, Section 7. Given the proposed mine project has changed significantly since 2006, NMFS recommends the project proponent apply for water rights permits that match the amounts of water needed for the current 25-year mine project. If the project proponent chooses to stick with requests for these larger withdrawals, NMFS will assume that they plan to construct the expanded mine, and evaluate the EFH Assessment in this light.
Water Use and Mangement	Surface Water Right Applications dated July 7, 2006, are for the following amounts:			*Upper Talarik Creek 28.9 cfs, NF Koktuli River 34 cfs, SF Koktuli River 51 cfs: estimated total water use of 113.9. Additional groundwater applications, with a priority date of September 21, 2006, are for the following amounts: SF Koktuli River 11.78 cfs, and an estimated 20 cfs from Upper Talarik Creek.*	Withdrawing these water volumes would dry out many miles of tributary streams in dry periods and kill juvenile salmon and salmon eggs. NMFS recommends the project proponent explain how they will withdraw and use 113.9 cfs, when the current plan only includes treatment capacity for a maximum of 44 cfs. Will the project proponent return the extra 69.9 c.f.s. to the streams untreated?

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Knight Piesold 2018a - Pebble Mine Site Operations Water Management Plan					
Project Description	Knight Piesold 2018a	1.1 Project overview	Pg. 1 PDF Pg. 6	*"The Bulk TSF south embankment is proposed to include a hydraulic barrier, consisting of a HDPE liner or a low permeability core zone, and a grout curtain installed in the weathered bedrock of the foundation."*	This sounds like the design of the south embankment is not complete. NMFS recommends USACE/project proponent complete the design of the south embankment and HDPE project liner and then present calculations on the leakage coefficient.
Water Quality	Knight Piesold 2018a	2.2 Climate Characteristics, 2.2.1 Setting	Pg. 5 PDF Pg. 10	*"and conditions are quite wet, with mean annual precipitation varying throughout the project area but generally ranging from 45 in. to 55 in."*	Capturing and treating 45-55 inches of precipitation annually over 10 square miles is a huge task. NMFS requests USACE/project proponent provide a typical per acre foot cost of removing the level of metals the project needs to remove. Explain how many acre feet will need to be treated in the first 30 years.
Water Quality Watershed Module	Knight Piesold 2018a	2.2.3 Long Term Monthly Temperatures and Precipitation at Pebble 1	Pg. 10 PDF Pg. 15	*"The estimated long-term mean annual precipitation at Pebble 1 is 54.6 in."*	This average is not possible if either the statement of 45-55 inches of precipitation on page 5 is correct or Figure 2.2 is accurate. While the discrepancy in these estimates sounds small over the years it will vastly change the cost of water treatment. PLP estimates of volumes needing treatment are much more precise than their estimates of pre-processing water chemistry. NMFS recommends USACE/project proponent synchronize their estimates of precipitation, including possible changes due to climate, and present a range of water chemistries, and then explain how the water treatment plants will meet this challenge.
Watershed Module Climate	Knight Piesold 2018a	Drainage Basins and Hydrometeorological Station Locations in the Project Area	Fig. 2.2 PDF Pg. 12	Precipitation map - values derived by SE - The pit itself at approximately 1050 feet will get 50-55 inches annually. The tailings facilities at 1730 feet, will get 65-75 inches annually.	NMFS recommends USACE/project proponent answer the following questions. -Is Fig 2.2 assuming the future climate replicates the past? -If the rate of climate change in central Alaska from 1990-2019 is replicated from 2020 to 2050, then how much precipitation is expected in the 2040-2060 time frame? NMFS recommends USACE/project proponent use several downscaled climate models recognized by IPCC to make these predictions.
Watershed Module Precipitation	Knight Piesold 2018a	2.2.3 Long Term Monthly Temperatures and Precipitation at Pebble 1	Table 2.1 Pg. 11 PDF Pg. 16	*Table 2.1 Monthly and Annual Temperature Statistics for Pebble - Statistics of a synthetic temperature series for the Pebble 1 station location, estimated on the basis of the Iliamna Airport record (1942-2017), as described in Memorandum VA18-00250 (KP2018A)*	NMFS requests USACE/project proponent explain how many months of the 75-year (900-month) synthetic record at the Pebble site there was no or incomplete precipitation information from the Iliamna Airport meteorological station. For months where they relied on King Salmon meteorological data, NMFS requests USACE/project proponent describe the precision of the precipitation estimate. King Salmon weather may be reliant primarily on moisture from the Bering Sea. The Pebble site is likely more influenced by Gulf of Alaska weather systems.
Peak Storm Events	Knight Piesold 2018a	2.2.6 Extreme Precipitation	Pg. 14 PDF Pg. 19	*The IDF curves were generated according to the NOAA Atlas 14 Volume 7: Precipitation-Frequency Atlas of the United States, Alaska (NOAA, 2012), with adjustments for specific location and orographic effects.*	NMFS recommends USACE/project proponent incorporate more recent work into these models, including Curran 2016 (https://pubs.er.usgs.gov/publication/sir20165024)
Groundwater Surface Water Interbasin transfers	Knight Piesold 2018a	2.3.3. Streamflow Records	Table 2.3 Pg. 15 PDF Pg. 20	*Table 2.3 Mean Seasonal Flow Distribution (2004-2015) - Annual hydrographs of mean monthly discharge for the four gaging stations located closest to the mine site are presented on the following Figures 2.7 to 2.10. Hydrographs are presented for both the measured records (including gaps infilled using regression relationships) and for the long-term estimated streamflow series generated using the watershed module.*	UTC is the driest of the three watersheds, with most areas in the 40-50 inch range. If UT119A streamflow gauge averages 98.1 inches/year unit discharge, that suggests 1/2 the water is groundwater that crosses the SFK-UTC boundary. SFK100C at 10.8 in/year is also VERY surprising as it drains high amounts of precipitation upland. The numbers presented in this table either indicate huge interbasin groundwater transfers or less than rigorous stream monitoring. Both scenarios suggest the applicant will be dewatering UTC in the best case scenarios and moving acid mine drainage that direction in worst scenarios. NMFS recommends USACE/project proponent explain the meaning of the data in this table in more detail.
Precipitation	Knight Piesold 2018a	2.3.3. Streamflow Records	Figure 2.11 Pg. 18 PDF Pg. 23	*Daily Discharge Hydrographs of NK119A for Driest Year (2011) and Wettest Year (2013) on Record*	NK119A had a one day average discharge above 500 cfs on about Oct 20, 2013. NMFS requests USACE/project proponent explain how the various TSF and WTP would deal with this volume of water. The project's total combined treatment capability is 44 cfs, and that 500 cfs was not from the whole mine site.
Surface Water	Knight Piesold 2018a	2.3.5 Peak Flows	Figure 2.7 - Pg. 16/PDF Pg. 23 Pg. 20/PDF Pg. 25	*"Peak flow curves were generated for mainstem river channels and upland tributaries in the mine study area and presented in the 2012 Hydrometeorology Report (KP, 2012)"*	NMFS recommends USACE/project proponent include the 2013 high flow event in the peak flow curves. For however many years the NK119A flow dataset exists, the 2013 high flow should have that number of years as its recurrence interval.
Groundwater	Knight Piesold 2018a	2.4 Groundwater Characteristics	Pg. 20 PDF Pg. 25	*"Below the upper bedrock zone (upper 50 feet), the hydraulic conductivity generally decreases with depth but includes some elevated-permeability zones that are typically associated with faults. The available data suggest that many of the faults act as flow barriers perpendicular to their strike, while some of the structures demonstrate an enhanced permeability in the direction of strike."*	NMFS requests USACE/project proponent list the structures (faults) data suggest have enhanced permeability. For the areas in the deep stratum where it has been determined that there are no faults, NMFS requests USACE/project proponent present the data that led to this conclusion.
Groundwater	Knight Piesold 2018a	2.4 Groundwater Characteristics	Pg. 20-21 PDF Pg. 25-26	*"High rates of water return during air-rotary drilling indicate that the hydraulic conductivity is usually relatively high in the upper bedrock due to weathering and frost disturbance. The weathered and disturbed zone is typically up to about 50-ft thick."*	NMFS requests USACE/project proponent explain if the fractured bedrock groundwater model layer is one thickness for the entire area. If not, NMFS requests USACE/project proponent explain how they determined the thickness in different areas.
Groundwater	Knight Piesold 2018a	2.4 Groundwater Characteristics	Pg. 22 PDF Pg. 27	*"The groundwater quality within the mine study area was assessed based on the collection of samples from 80 groundwater monitoring wells with depths up to about 200-ft and samples collected at drillhole DH-8417 at depths from 640 to 4,050-ft."*	NMFS recommends USACE/project proponent collect water quality samples from more than a single hole (DH-8417) deeper than 200 feet. NMFS recommends having at least a similar amount of sample locations for deep water quality as for shallow water quality (80 sample locations).

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Peak Storm Events	Knight Piesold 2018a	3.4 Water Management Facilities	Table 3.1 Pg. 28 PDF Pg. 33	*Table 3.1 Design Criteria for the Water Management Structures: This does give capacities for most WMP and TSF.*	NMFS commends USACE/project proponent for providing sizes for the various water treatment facilities. NMFS recommends USACE/project proponent demonstrate how the facilities would deal with an atmospheric river of storms with the first dumping 7 inches in 24 hours, 4 days later another storm dumping 4 inches, and 4 days later a third dumping 4 inches. This total of 15 inches in 9 days is not a far-fetched scenario even under current climate conditions.
Peak Storm Events	Knight Piesold 2018a	3.4.3 Main Water Management Pond	Pg. 29 PDF Pg. 34	*"The Main WMP will be a lined facility, with underdrains installed below the liner to direct groundwater drainage under the facility and towards the sediment control pond."*	NMFS recommends USACE/project proponent explain how full this pond will be on a regular basis and how high it would get under the 15 inches scenario in 9 days presented above.
Water Quality	Knight Piesold 2018a	3.4.5 Bulk TSF Main Embankment Seepage Collection Pond	Pg. 30 PDF Pg. 35	*"An emergency spillway will be set at an elevation above the IDF freeboard and will direct discharges towards the NFK."*	When the Inflow Design Flood (IDF) comes, a lot of fish will die in the NFK. While this will be a rare event, NMFS requests USACE/project proponent describe the NFK water quality during the event, and the percentage of fish that are expected to die. How will the water quality of the surface and groundwater be 2 weeks later? NMFS recommends USACE/project proponent show the modeling for whether the untreated mine water remains in the groundwater or washes out to Bristol Bay. In the days after the spill event, what would the water quality be in the mainstem Koktuli?
Water Quality	Knight Piesold 2018a	3.4.6 Pyritic Tailings and PAG Waste Rock Storage Facility	Pg. 31 PDF Pg. 36	*"Underdrains will be included below the facility to direct groundwater and seepage to a collection pond downstream of the main Pyritic TSF embankment."*	NMFS requests USACE/project proponent provide more detail on how these underdrains are designed and what percentage of the leakage they will catch.
Watershed Module Climate	Knight Piesold 2018a	4.3 Mine Plan Module Water Balance Results - 4.3.1 Annual Average Balance	Pg. 34 PDF Pg. 39	*"Realization #10 was selected to represent relatively wet conditions because it contains a period that results in high environmental discharge releases. The average annual precipitation for realization #10 is 57 in., but the annual precipitation for the final year of operations is 93 in."*	Based on the data presented in Knight Piesold 2018a fig 2.2, Realization 10 may be closer to average. If the final year is 93 inches and the average is only 57 inches for 3 years, the first two years must be drought years. NMFS recommends USACE/project proponent contract independent climate modelers (NMFS recommends UAF) to come up with the 24 h, 72 H, 1 week, 1 month, 1 year, and 3 years one-in-hundred reocurrence interval wettest events for the decades the mine is likely to operate. Once this is done NMFS recommends USACE/project proponent revisit the plan and assess its effectiveness in light of the climate model.
Groundwater	Knight Piesold 2018a	4.3 Mine Plan Module Water Balance Results - 4.3.1 Annual Average Balance	Table 4.1 Pg. 35 PDF Pg. 40	*Table 4.1 Average Annual Site Wide Surplus Flow for Individual Realizations Representing Relatively Dry, Average, and Relatively Wet Conditions - "The surplus flow is an indication of the amount of water that is collected and managed within the project mine site. The surplus flow is not directly related to the amount of water treated and released downstream of the project site at any one time since the site surplus does not take into account the change in water stored within the water management ponds."*	This table is counterintuitive. NMFS requests USACE/project proponent explain why more water will not move through the overburden and to the pit in wet years.
Water Quality	Knight Piesold 2018a	5.3 Water Quality Model Inputs and Assumptions	Pg. 42 PDF Pg. 47	*Complete mixing under steady state conditions (i.e., no reactions or degradation occurs) for all facilities and flow streams except for the concentrations in the tailings slurry leaving the process plant and the concentrations in the Bulk TSF and Pyritic TSF, as directed by SRK and described below:*	NMFS does not agree with "Complete mixing under steady state conditions (i.e., no reactions or degradation occurs)." NMFS recommends USACE/project proponent evaluate what is occuring in similar pyritic ponds around the world and assume that will happen here. This is a large task, but this oversimplied "no reactions or degradation" will not allow anyone to model water quality, or understand effects on stream water quality or fish habitat.
Water Quality	Knight Piesold 2018a	5.4 Water Quality Model Results and Discussion	Pg. 43 PDF Pg. 48	*"The water treatment plants are being designed by others based on the flow rate results of the water balance model and the water quality predictions from the WQ model."*	NMFS recommends USACE/project proponents present details on the water treatment plants which need to treat up to 15 - 44 cfs continuously.
Groundwater	Knight Piesold 2018a	6.0 Summary	Pg. 44 PDF Pg. 49	*"Groundwater plays a prominent role in the flow patterns of all the creeks and rivers in the Project area."*	NMFS requests USACE/project proponent explain how piping reclaimed water back to surface streams fixes groundwater fluxes. Most of the treated water should be used to recharge groundwater just outside the zone of influence with groundwater recharge wells.
Inflow Design Flood	Knight Piesold 2018a	6.0 Summary	Pg. 44 PDF Pg. 49	*"All water management facilities will have provisions in place to handle IDF flows either through storage or spillways."*	Handling IDF flows through spillway designs means the plan is to spill untreated AMD, which is not acceptable. That AMD water may recharge the huge gravel aquifers and then slowly move back into the stream over months. NMFS recommends USACE/project proponent oversize facilities so that an overflow channel will not be needed in the next 1000 years (far past the time period that this project is expected to have any effect on the environment in this area).
Water Quality	Knight Piesold 2018a	Appendix A Water Balance Flow Schematic and Average Annual Flow Balance	Table A.1 Pg. A-1 - A-2 PDF Pg. 54-55	*Table A.1 Average Annual Flow Balance*	The not yet designed dewatering wells are not in this chart. While perhaps the dewatering well water does not need to be treated, it surely affects groundwater to the pit. Groundwater withdrawn above the pebble deposit may need to be treated. NMFS request USACE/project proponent include all dewatering wells in all analysis of flow balance.
Water Quality	Knight Piesold 2018a	Appendix A Water Balance Flow Schematic and Average Annual Flow Balance	Fig. A.1 Pg. A-3 PDF Pg. 56	*Fig. A.1 Water Balance Flow Schematic - Operations*	This diagram does not present the concentration that will develop in these facilities or demonstrate that the volume of water can be treated to the listed standards. NMFS recommends USACE/project proponent design a way to detail water qualities in different facilities at different times during the mine life and in different weather scenarios.

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Water Quality	Knight Piesold 2018a	Appendix B Water Quality Model Inputs and Results	Table B1.1 Pg. B1-1 PDF Pg. 59	*Appendix B1 Water Quality Source Terms and Assumptions Table B1.1 Water Quality Source Terms and Assumptions - 95th Percentile Geochemical Source Terms*	Considering the open pit has 5 - 10 identified bodies of ore, NMFS recommends USACE/project proponent explain how they estimated a single source water chemistry. NMFS conjectures that the water chemistry would change as the pit deepens/expands and different ore bodies are encountered. This same concept applies to a single water chemistry being applied to all waste rock. NMFS also requests USACE/project proponent explain if the source water chemistry from tributaries NK119A and SK100F was after most exploratory wells were drilled or before. Does this reported background water chemistry match nearby streams with no drill holes in the watershed?
Water Quality	Knight Piesold 2018a	Appendix B Water Quality Model Inputs and Results	Table B1.2 Pg. B1-2 PDF Pg. 60	*Appendix B1 Water Quality Source Terms and Assumptions Table B1.2 Water Quality Source Terms and Assumptions - Source Term Assumptions*	NMFS recommends USACE/project proponent select which 10 - 15 water source terms matter most, and provide error bars on accuracy of each identified source term.
Knight Piesold 2018g - Hydrometeorology Report					
Climate Change	Knight Piesold 2018g	3.3.2 Extreme 24-Hour Rainfall	Pg. 42 Fig 3.7 Table 3.12	*KP Estimate (Non-Winter Months Only; Extreme 24-hour Rainfall Estimates; 1977-2017 (in) 10 year -4.38; 25 year - 5.34; 50 year 6.14. 100-year- 7.0*	The 24-hour max precipitation value for a 100-year return period is likely to become the 25-year return period before the pit is filled (40 years). That means on a 10-square mile mine footprint the project could need to deal with 7 inches of rain spread over 6,400 acres in 24 hours. This is 3,733 acre feet of water storage that needs to be constantly available. The 44 cfs capacity of treatment is only 88 acre feet a day. NMFS requests USACE/project proponent explain where this 3,733 acre feet of storage is during operations. Once an atmospheric river sets up, it often brings several large storms in a row. Please explain what happens if that large of a storm is followed by one half as big four days later.
Knight Piesold 2018i - Response to RFI 019 Part 2 Estimated Mine-affected Streamflow Values at End of Mine Questions					
Watershed Module Weather data	Knight Piesold 2018i	2.0 Watershed Module Description and Results	Pg. 2 PDF Pg. 2	*"The Watershed Module was developed in Microsoft Excel and run on a monthly time-step"*	This module is just recasting the monthly numbers from the last 912 months, but that 912 month dataset is synthetic. Most of it was crosswalked from Lake Iliamna airport meteorological station at 187 feet elevation and then projected to the pit elevation of 1050 feet or the bulk tailing elevation of 1,730 feet. Recasting past data also ignores that the climate has changed. NMFS recommends USACE/project proponent use a more reliable, consistent meteorological model that considers the effects of climate change in their Watershed Module.
Watershed Module Weather data	Knight Piesold 2018i	2.0 Watershed Module Description and Results	Pg. 2 PDF Pg. 2	*"The modeling approach uses Microsoft Excel, which precludes the ability to demonstrate spatially the extent of this capture zone."*	A project of this size should use a model more sophisticated than an Excel spreadsheet. In order to evaluate effects to EFH, NMFS also needs to know 24-hour, 48-hour, and 72-hour maximum precipitation amounts, which a monthly model does not predict. The mine footprint extends from 950 feet in elevation to about 2,500 feet. NMFS requests USACE/project proponent explain how different amounts of rain were forecasted for different elevation bands. How does the model deal with the fact that the topography will change and the tailing facility will gain several hundred feet of height as the pit is excavated?
Groundwater Surface Water	Knight Piesold 2018i	Estimated Streamflow at Pre-Mine and End of Mine Without Treated Water Discharge	Table 2 PDF Pg. 6	This table shows that only two streams SK100c and NK119A are expected to lose groundwater contributions at End of Mine without treated water discharge.	NMFS request USACE/project proponent explain why they expect SK100C and NK119A to be the only streams to lose groundwater contributions. NMFS recommends USACE/project proponent give a detailed explanation of how they concluded that other streams will not lose groundwater contributions, considering especially the 6 streams to the SE of the pit that flow into the Upper Talarik.
Groundwater Surface Water	Knight Piesold 2018i	Estimated Streamflow at Pre-Mine and End of Mine With Treated Water Discharge	Table 3 PDF Pg. 7	This table shows that six SFK tributaries and 3 NFK tributaries all lose surface water but only one stream (NK119A) loses groundwater at End of Mine with treated water discharge.	Since the project returns some surface water after treatment to streams, but never makes any attempt to restore groundwater, NMFS recommends USACE/project proponent explain why they only expect one stream to lose its groundwater component in this water treatment scenario.
Surface Water	Knight Piesold 2018i	General Arrangement Maximum Footprint	Figure 1 PDF Pg. 9	*General Arrangement Maximum Footprint*	This figure shows flow reduction area to be a very narrow donut around the pit. This seems to conflict with other descriptions. This also implies zero flow reduction in UTC, which is not correct because the zone of influence extends into the UTC. NMFS recommends USACE/project proponent explain how they concluded that there will be no flow reduction in UTC.
Knight Piesold 2018n - Response to RFI 19c Questions					
Closure Groundwater	Knight Piesold 2018n	Response to RFI questions 2.19	Pg. 8 PDF Pg. 8	*Question 19 Response: "The Not to Exceed elevation of 900 ft for the pit lake was specifically designed to prevent groundwater seepage from the pit, i.e. to prevent "flow reversal". Stated another way, the Not to Exceed elevation of 900 ft is intended to maintain the groundwater flow direction toward the pit and to prevent groundwater outflow from the pit."*	In Schlumberger 2011, 0.0014 m/s HC value was attributed to one of the ore bodies in the pit. Schlumberger said it was an anomalous condition. Schlumberger does not claim it was erroneous data, just an odd area of bedrock (or more correctly a fault). Reponse #19 assumes all the flow in and out of the pit is (and will always be) through the overburden. Since a hydraulic conductivity in the bedrock below the pebble deposit was 0.0014 m/s in one location, the response is not logical. NMFS recommends USACE/project proponent explain where the water in that ore body originated.
Groundwater	Knight Piesold 2018n	Response to RFI questions 2.21	Pg. 8 PDF Pg. 8	*Question 21 Response: "A monitoring plan will be developed as part of future design work, and will target zones of expected higher permeability between the active mine facilities and the receiving environment that are identified from site investigations and during operations.These areas may include fractured bedrock zones, deeper weathering profiles along streams, and thicker permeable overburden deposits. "*	NMFS cannot complete our full evaluation of the project's effects on EFH if the plan to monitor water movement has not been developed. Fish need water. NMFS recommends USACE/project proponent fully develop a water monitoring plan.

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Pond liner	Knight Piesold 2018n	Response to RFI questions 2.23	Pg. 9 PDF Pg. 9	*Question 23 -The Main Water Management Pond will be designed to minimize leakage to the extent possible. A monitoring plan will be developed as part of future design work, and will target zones of expected higher permeability between the TSF and receiving environment that are identified from site investigations.*	NMFS recommends USACE/project proponent state the amount of leakage they expect. NMFS recommends basing these estimations on other similarly sized, lined water management ponds in the US and Canada.
Groundwater Model	Knight Piesold 2018n	Hydraulic Conductivity and Storage Zone	Fig. 6 and 7 PDF Pg. 16-17	*Hydraulic Conductivity and Storage Zones*	-Especially in the lower layers, NMFS recommends USACE/project proponent describe the boundary conditions and how/why they chose not to have the model cover a larger area. -For each zone k, ss, and sy are listed. NMFS requests USACE/project proponent detail the well data that went into each number and indicate which layers did not have hydraulic conductivity measurements taken.
Groundwater Model	Knight Piesold 2018n	Steady State Recharge	Fig. 9 PDF Pg. 19	*Steady State Recharge*	NMFS recommends USACE/project proponent describe how this set of steady state recharge values was derived.
Groundwater Model	Knight Piesold 2018n	Box and Whisker Plots Hydraulic Conductivity	Fig. 10 PDF Pg. 20	*Box and Whisker Plots Hydraulic Conductivity*	In most of the documents, there is one hydraulic conductivity value derived from a slug or response test. Now it is divided into the kx and ky components that are needed for a model. NMFS requests USACE/project proponent describe how these components were determined.
Groundwater	Knight Piesold 2018n	Shallow Groundwater	Fig. 13 PDF Pg. 35	*RFI 19C Question 20 Shallow Ground water*	This indicates shallow groundwater has different watershed boundaries than surface water. Should the eastern pit wall not be impermeable, water from the pit will move towards the Upper Talarik. NMFS requests USACE/project proponent describe how the shallow groundwater boundaries were determined.
Knight Piesold 2018p -Response to EIS-FMEA Failure Scenario for Pyritic TSF Questions					
Tailings	Knight Piesold 2018p	2.1 Pyritic TSF Description	Pg. 3	*"The Pyritic TSF will sub-aqueously manage approximately 155 million tons of pyritic tailings and 160 million tons of PAG waste rock"*	The size of the Pyritic TSF varies between the USACE permit application, the DEIS, and the Draft EFH Assessment. NMFS requests USACE/project proponent to clarify the actual planned size of this extremely important facility in the final EFH Assessment.
Tailings	Knight Piesold 2018p	2.2 EIS-FEMA Failure Scenario for Pyritic TSF	Pg. 4	*Overtopping failure results in partial down-cutting to El. 1,704 ft (breach depth of 6 ft.) DRAFT Document. The bottom of the breach for this analysis was determined during the EIS-FMEA workshop and prescribed as 6 ft; therefore, the bottom elevation of the breach was not based on the recommendations from ADSP. (pg 12)*	When a 300 ft+ tailings embankment with several hundred acres of standing water behind it breaches, it rarely cuts down 6 feet and stops. There have been dozens of breaches to similar sized tailing facilities in the last few decades (icold 2001). NMFS recommends the project proponent review these breaches and plan for a breach as deep as the ones in the worst 25%.
Knight Piesold 2018r - Response to Operations Water Balance and Water Quality Model Sensitivity Analysis Questions					
Climate Change	Knight Piesold 2018r	1.0 Introduction	Pg. 1	*A sensitivity analysis on the climate inputs (i.e. temperature and precipitation values) was not completed because it is unnecessary since the base model was developed as a climate variability model that utilizes the entire 76-year synthetic time-series of monthly temperature and precipitation values developed for the Pebble Project site (the Project).*	This logic that the past 76 years represents the future is not consistent with the DEIS (4.17-3) and will not allow USACE/project proponent to accurately conduct an EFH assessment. The climate will change while this project is operating. Climate variability is important and can be represented by the 76 year data record, however, climate variability is not the same thing as climate change. NMFS recommends the project applicant work with respected climate scientists (NMFS recommends UAF) to better understand an appropriate way to model future climate - especially rainfall.
Lorax Environmental 2018 - Pebble Project Pit Lake Water Quality Predictions					
Water Quality	Lorax Environmental 2018	4. Model Results	Pg.7 Table 3	*Table 3: Summary of predicted surface water quality for the Pebble Pit Lake. Data represent mean annual values in uppermost 10 m of the water column (approximate depth of surface mixed layer). Pit lake reaches maximum elevation in Closure Year 21.* Seventeen constituents will go into the Water Treatment plant above water quality standards.	NMFS understands that water treatment will remove some metals and high levels of 17 elements is not unusual for a mine, but the predicted levels over State of Alaska water quality standards for this mine 20 years after mine closure are as follows: Cadmium:100 times over Lead:10 times over Molybdenum: 60 times over Zinc:10 times over If even a small amount of mine contact water avoids the treatment plant, once mixed, the lower watershed will not meet standards for these 4 constituents. Also this is 232 million cubic meters of water that needs treatment. If one percent avoids treatment, that is 2.3 million cubic meters of water with very high concentrations of metals. Most porphyry mines exceed water quality standards on a regular basis. The groundwater below porphyry mines is usually high in metals once mining begins. NMFS request USACE/project proponent suggest why this mine would be any different.
Piteau Associates 2018 - Groundwater Conditions at End of Mining and Post-Closure					
Dewatering	Piteau 2018	2. Background and Assumptions - Groundwater Model Background	Pg. 3 PDF Pg. 7	*"The design of the tailings management and water management facilities is in the process of being finalized"*	NMFS cannot complete our full evaluation of the project's effects on EFH if the dewatering plan is not finalized. NMFS requests USACE/project proponent provide a complete pit dewatering plan.
Dewatering	Piteau 2018	3. Scenarios	Pg. 5 PDF Pg. 9	*"The zone of influence is often larger than the capture zone because the groundwater elevations can be affected outside the groundwater divide that defines the capture zone"*	Especially in the UTC and SFK drainages, NMFS recommends USACE/project proponent explain how much further the "zone of influence" extends past the "capture zone". NMFS recommends USACE/project proponent define the farthest reach of the zone of influence.
Surface Water	Piteau 2018	Figures	Fig. 4 PDF Pg. 22	*Comparison of the 50th Percentile and Double Recharge Scenario End of Mining Capture Zones*	Five tributaries (each approximately 1 mile long) flow into the UTC from the northeast side of the pit. This model shows two affected and three not affected. NMFS recommends USACE/project proponent explain the detailed level of effect on each of the five streams since part of each of their watershed is in both the "capture zone" and the "zone of influence".

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EFH	Piteau 2018	Figures	Fig. 5 PDF Pg. 23	*Zones of Influence for Open Pit, Pyritic TSF, and MWM Pond at End of Mining and Post-Closure (Base Case)*	This shows all six tributaries affected and four likely to lose most of their winter water. NMFS recommends USACE/project proponent explain how salmon eggs will not freeze if the winter upwelling stops.
Mitigation	Piteau 2018	Figures	Fig. 5 PDF Pg. 23	*Zones of Influence for Open Pit, Pyritic TSF, and MWM Pond at End of Mining and Post-Closure (Base Case)*	These models and their various scenarios rely on estimated model parameters. NMFS recommends USACE/project proponent explain what steps they will take to reverse the damage if the models prove to be inaccurate when the pit is dug. For example, if one of the three drainages (SFK, NFK or UTC) ends up with a shallow aquifer containing 100,000 acre feet of water with metal concentrations above APDES standards, how will they remove/clean up that water?
Schlumberger 2015a: SUPPLEMENTAL ENVIRONMENTAL BASELINE DATA REPORT 2004 - 2012					
Groundwater Model	Schlumberger 2015a	8.1.6.2 Field Program	Pg. 8-7 PDF Pg. 15	*Two holes were drilled in 2011 (DDH-11531 to 2458 ft and DDH-11535 to 2277 ft) and two holes were drilled in 2012 (DDH-12548 to 1106 ft and DDH-12551 to 3006 ft). Based on air lift testing, sufficient yield was not found to justify a long term pump test in any of the four holes.*	NMFS recommends USACE/project proponent explain how effective air lift testing is at 2,000 feet of depth, and if other methods were attempted.
Faults	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.3 Summary of Site Subsurface Investigations	Pg. 8-11 PDF Pg. 19	*"Faulting was common across the site, which is typical of this type of geologic environment. Although faulting is expected to result in more permeable zones in the vicinity of the fault, the offsets caused by faulting and the fine-grained fault gouge likely contribute to compartmentalization of the bedrock groundwater system."*	Since faulting is common across the site, NMFS requests USACE/project proponent detail the method they intend to use to evaluate each of those faults. NMFS requests a clear map showing all faults within 5 miles of the current mine footprint. NMFS recommends USACE/project proponent consider tracer dye test or other means of identifying where water inserts into a dozen fault resurfaces.
Faults	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.4 Response Tests	Pg. 8-12 PDF Pg. 20	*"Some of the highest hydraulic conductivity values determined may be within the range of the effective value for the screen and filter pack. In these cases, the actual hydraulic conductivity of the formation might be higher than the calculated value."*	NMFS requests USACE/project proponent explain what hydraulic conductivities they fed into the groundwater model considering that "actual hydraulic conductivity of the formation might be higher" for the majority of the tests.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.4 Response Tests	Pg. 8-12 PDF Pg. 20	*"The hydraulic conductivities calculated from the response tests across the whole study area ranged from about 1x10-8 meters per second (m/s) to about 1x10-2 m/s (Figures 8.1-9a, 8.1-9b, and 8.1-9c)."*	1X10-2 m/s hydraulic conductivity is essentially an underground river. NMFS recommends USACE/project proponent describe the steps they will take to keep all mine contact water out of this stratum. Once contamination enters this stratum, containment will be near impossible.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.4 Response Tests - Pebble Deposit Area	Pg. 8-13 PDF Pg. 21	*Response tests in bedrock in the Pebble Deposit area were performed near the top of rock (shallow bedrock). Hydraulic conductivities ranged from 4x10-7 to 1x10-3 m/s (Table 8.1-1).*	USACE/project proponent often provides the geometric mean of a lot of tested HC values. Wouldn't mine contact water follow the path of least resistance? The dozen or so ground strata and faults with high conductivity will move 99% of the groundwater both toward and away from the mine site. NMFS requests USACE/project proponent explain the value of reporting the geometric mean hydraulic conductivity.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.4 Response Tests - South Fork Koktuli "Flats" Area	Pg. 8-13 PDF Pg. 21	*The hydraulic conductivities in shallow bedrock ranged from 1x10-8 to 3x10-3 m/s (Table 8.1-3)*	SFK "flats" are a crucial area where water moves between the two drainages. Should SFK aquifer begin to become acidic, NMFS recommends USACE/project proponent describe their plan for keeping the UTC water and Lake Iliamna from also becoming contaminated.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.4 Response Tests - Upper Talarik Area	Pg. 8-14 PDF Pg. 22	*"The hydraulic conductivities in overburden ranged from 2x10-6 to 4 x 10-5 m/s (Table 8.1-5)." "The hydraulic conductivities in shallow bedrock ranged from 2x10-7 to 2 x 10-5 m/s (Table 8.1-5)."*	Only 12 shallow tests in the UTC watershed have been reported. NMFS's and the Alaskan public's biggest concern is mine contact water moving toward Lake Iliamna. NMFS recommends USACE/project proponent do more HC tests in UTC drainage, including some pumping tests, and target the locations most likely to contain faults or fractures. Since the ore body is under here, weren't response or pump tests done in any of those deep exploratory holes?
Groundwater Model	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.5 Pumping Tests	Pg. 8-14 PDF Pg. 22	*"Pumping tests comprise pumping from one well and measuring response to pumping in adjacent wells. A pumping test provides more reliable and representative aquifer parameters than a response test because the pumping rates are relatively high, which increases the radius of influence of the test and minimizes the effects of formation damage that result from drilling and well construction on measured hydraulic conductivity. Pumping tests were completed at nine locations: PW-1, PW-3, PW-4, PW-5, PW-6, PW-7, PW-8, PW-08-9, and PW-08-10 (PW-2 was not drilled)."*	NMFS requests USACE/project proponent explain why they rely heavily on response tests when the reports they commissioned suggest these tests are not very precise.
Groundwater Model	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	Pumping Tests 8.1.7.5	Pg.8-14 - 8-15 PDF Pg. 22-23	*"The hydraulic conductivities calculated for overburden pumping tests were almost an order of magnitude higher than the highest values calculated from the response tests, indicating that the response tests in these overburden materials tend to underestimate the hydraulic conductivities of the overburden."*	USACE/project proponent relies more heavily on response tests than pumping tests to calibrate the 10-layer groundlevel model. NMFS requests an explanation of why it is scientifically defensible to use the lower HC measured during response tests to parameterize the groundwater model. If both types of HC data were used, explain why the modelers chose one or the other.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.6 Bedrock Testing by Knight Piesold	Pg. 8-15 PDF Pg. 23	*Within the Pebble Deposit area, the hydraulic conductivities were measured to depths of up to 4,500 feet but were mostly in the upper 1,000 feet.*	NMFS requests USACE/project proponent provide an exact inventory of all hydraulic conductivity tests done below 1,000 feet of depth, the method used, and an estimate of the precision.
Water Quality	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.11 Groundwater Sampling	Pg. 8-22 PDF Pg. 30	*"In general, groundwater that has low total dissolved solids (TDS) and high dissolved oxygen (DO) is recharging and moving through the system relatively quickly.* *"Groundwater within the study area was characterized by very low TDS (median concentrations typically less than 100 milligrams per liter [mg/L]) and high DO (most wells greater than 8.5 mg/L)".*	Water with high dissolved oxygen and low TDS almost always fell recently as rain or snow. Depending on the environment, this could mean days or perhaps up to a couple months prior. The fact that this water is being found in the overburden and down deep means there are efficient flow paths to get it there quickly. If rainwater penetrates to 1,000 feet fairly quickly, mine drainage high in metals will do the same. NMFS requests USACE/project proponent describe how this water is going deep so fast and how they will manage groundwater knowing that a network of conductivity must exist.

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Water Quality	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.11 Groundwater sampling	Pg. 8-23 PDF Pg. 31	*"The median concentrations of DO in overburden ranged from 10 to 13 mg/L in the NFK watershed, from 0.5 to 13 mg/L in the SFK watershed, and from 0.2 to 13 in the UT watershed. The consistently high median DO concentrations in the NFK watershed indicated that oxidation processes were limited, which suggests partly that recharge rates and groundwater velocities are relatively high"*	As presented (Detterman and Reed 1973, Stilwell and Kaufman 1996, Hamilton and Klieforth 2010), this landscape is the result of extensive glacial recession and watershed-wide fluvial processes. The deposits are poorly sorted unconsolidated gravels, pebbles, rocks, and cobble materials. Material overburden of this nature has a high flow and recharge capacity for temporary storage and conveyance (flow through) of groundwater. The depth and porosity (hydrologic conductivity) of these deposits indicate expansive groundwater regimes making accurate water management a priority for this project. This complex layering in the overburden is responsible for the excellent salmon habitat. The complexity of the overburden and abundant volumes of well-oxygenated groundwater suggests water management in excavations at this scale will be challenging through every phase of construction, operation and closure. Furthermore, given the probability of the extended mine plan and deeper excavation [Permit Application Section D, Page 28 (78 year Mine Pit Dimensions)], the project may have to operate a series of deep barrier wells (previously mentioned) to dewater and access the larger excavation. Barrier wells across watersheds will create a series of "depression cones", which will alter hydrologic head gradients further downstream than currently presented or analyzed in this D-EIS or represented in any of the supporting documents or the water rights reservations (Dated July 7, 2006). NMFS requests USACE/project proponent explain how they will restore not just the visual surface vegetation, but all these layers.
Water Quality	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.11 Groundwater sampling	Pg. 8-23 PDF Pg. 31	*"In summary, the low concentrations of tritium and Total Dissolved Solids, and high concentrations of Dissolved Oxygen are consistent with relatively high recharge rates and groundwater velocities" (Page 8-23).*	NMFS recommends USACE/project proponents have an independent third party of specialists and subject matter experts review and compare the analysis in the water quality data - quickly moving, young groundwater - and the analysis in the DEIS that suggests the little water below the overburden moves slowly and has little to no contact with shallow groundwater.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.13 Hydrogeologic Characterization of SFK Drainage	Pg. 8-24 PDF Pg. 32	*"A deep aquifer identified within a bedrock low on the east side of the deposit (Figure 8.1-3a). Holes collared below about 970 feet on the Upper Talarik side of the divide flowed, some at rates in excess of 300 gpm. A pump test was performed in these materials (PW-08-09). The boundaries of this aquifer have been refined based on investigations since 2008 by SLR, KP and SRK"*	The drillholes in the Upper Talarik are within 1/2 mile of the pit wall in the 20-year plan, and perhaps actually in the pit under the 78-year plan. Either way, below 970 feet there is an aquifer that flowed at 300 gpm. When the pit first penetrates this aquifer it might drain it, or it could flow for years; it is very difficult to determine. Once the pit is refilled with mine tailing water, that water will flow into this aquifer. It may surface in SKF or UTC or Lake Iliamna or never surface. NMFS requests USACE/project proponent present precise information about where the water in this aquifer originates and where it goes and how much water that aquifer holds.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.7.13 Hydrogeologic Characterization of SFK Drainage 8.1.7.13 Hydrogeologic Characterization of SFK Drainage	Pg. 8-25 PDF Pg. 33 Pg. 8-24 PDF Pg. 32	*"Fault zones provide both conduits and barriers to groundwater flow." "Conduits are provided through fractured ground adjacent to a fault, and barriers are due to fault gouge with the fault itself." (Schlumberger 2015a, 8-25)* *"These faults probably act as flow conduits parallel to the fault structures and flow barriers perpendicular to the structures so that a compartmentalized groundwater system is developed." (Schlumberger 2011a, 8-39, typed)*	Both expansive groundwater reports commissioned by PLP clearly state that faults are a key to moving groundwater around below about approximately 300 feet. NMFS recommends that the EFH Assessment and DEIS clearly acknowledge this and analyze all faults.
Faults	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.8.1 Overview of Groundwater Baseline Program - Geology	Pg. 8-39 PDF Pg. 47	*"Below the upper bedrock zone (upper 50 feet), the hydraulic conductivity generally decreases with depth but includes some elevated-permeability zones that are typically associated with faults. The available data suggest that many of the faults act as flow barriers perpendicular to their strike, while some of the structures demonstrate an enhanced permeability in the direction of strike."*	NMFS recommends USACE/project proponent be more specific about the "enhanced permeability in the direction of the strike." State those permeabilities in numbers and include them in the groundwater model.
Groundwater Model	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.8.1 Overview of Groundwater Baseline Program - Geology	Pg. 8-39 PDF Pg. 47	*"High rates of water return during air-rotary drilling indicate that the hydraulic conductivity is usually relatively high in the upper bedrock due to weathering. The zone of weathering is typically up to about 50 feet thick."*	NMFS requests USACE/project proponent provide more detailed hydraulic conductivities in the weathered bedrock zone. Also describe how/if the dewatering wells will completely penetrate this weathered bedrock zone.
Groundwater	Schlumberger 2015a Chapter 8 - Groundwater Hydrology	8.1.8.1 Overview of Groundwater Baseline Program - Regional Hydrogeologic Setting	Pg. 8-40 PDF Pg. 48	*"most groundwater flow occurs at shallow levels within the overburden and shallow bedrock"*	NMFS agrees that the majority of groundwater is in either the overburden or shallow fractured bedrock.This mountainous area receives 50-60 inches of rain a year and if even the minority, say 5 to 10 percent, is in deeper aquifers, that is a substantial amount of water. There have been few hydraulic conductivity tests below 970 feet, but one in the Upper Talarik Creek drainage yielded 300 g.p.m. NMFS recommends USACE/project proponent continue collecting data about the aquifers between 1,000 and 4,000 feet deep until they have sufficient data to both calibrate and validate the groundwater model.

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Groundwater	Schlumberger 2015a Appendix 8.1C Response Testing Results	Falling Head Testing Results / Oscillating Response Testing Results	PDF Pg. 375 - 384	Slug Tests: Gh11-291 K= 5.8 km/year slug test (Pg. 50 / PDF 384) Gh11 301 K = 16.8 km/year (Pg. 52 / PDF Pg. 386) Gh11-340 K= 27 km/y (Pg. 54 / PDF Pg. 388) Gh11-341 K=18 km/year (Pg. 56 / PDF Pg. 390) Gh11-346 K=40.1 km/year (Pg. 60 / PDF Pg. 394) Gh11-257 K= 14.6 km/year (Pg. 46 / PDF Pg. 380) Gh11-251 K=45.6 km year (Pg. 44 / PDF Pg. 378) Gh11-349 K= 7.84 km/year (Pg. 41/ PDF Pg. 375)	These hydraulic conductivities are quite high. Sooner or later some water high in concentration of metals will escape the project footprint. After even a month, the area affected by the untreated water would be large. NMFS requests USACE/project proponent explain how long it will take to detect untreated water escaping from each tailings or water storage facility, and detail their cleanup plan.
Schlumberger 2011a: ENVIRONMENTAL BASELINE DOCUMENT 2004-2008 - Chapter 8 - Groundwater Hydrology					
Groundwater Model	Schlumberger 2011a Appendix 8.1J Groundwater Model Results	Figures	Fig. 4.7, 4.8, 4.9 PDF Pg. 2186 - 2188	These figures represent an oversimplified 4 layer model.	The current 10 or 8 layer groundwater model has the potential to be a large improvement, but that is only once it is calibrated and validated. NMFS recommends USACE/Project proponent indicate the two distinct datasets that will be used for these steps. Also provide a publicly accessible document that describes actions taken once those two steps are finalized.
Groundwater Model	Schlumberger 2011a Appendix 8.1K Multi-level Groundwater Monitoring System Schlumberger 2015a	1. Introduction 8.1.6.2 Field Program	Pg. 1 PDF pg. 2296 Pg. 8-6 PDF Pg. 14	*"Westbay multipiezometer (MP) system was installed in drillhole 6349 WB-1 to collect hydrogeologic information to a depth of 4000* *"A multi-level piezometer supplied by Westbay Instruments Inc. was installed in the Pebble Deposit area in 2006 in exploration drillhole 6349 (Appendix 8.1K of Chapter 8 of the 2004-2008 EBD). Two additional multi-level installations have been completed."*	NMFS does not understand how three deep wells with multi level installations can characterize the deep layers divided into 8 different units. NMFS recommends USACE/project proponent state which model units never had any kind of physical hydraulic response test and yet still are being assigned a value. NMFS recommends that for each unit in each of the 8 layer groundwater model, USACE/project proponent list the dates, types, and results of the hydraulic conductivity tests.
Faults	Schlumberger 2011a Appendix 8.1K Multi-Level Groundwater Monitoring System	2.1 Geologic Setting	Pg. 1 PDF Pg. 2297	*"DH 8417 intersects two steeply dipping faults ZE and ZEc. These faults strike approximate west to east and dip towards the south"*	This information about ZE and ZEc faults did not appear in the DEIS or the EFH Assessment. NMFS recommends USACE/project proponent include a detailed description of both faults in both the EFH Assessment and DEIS. Information about these faults is crucial to determine how far contaminated water might disperse and how it will affect EFH.
Groundwater Model	Schlumberger 2011a Appendix 8.1K Multi-Level Groundwater Monitoring System	2.2 Installation of Westbay Well WB-1	Pg. 2 PDF Pg. 2297	*" NDM-6349 was drilled to 4,054 feet ...."*	NMFS recommends USACE/project proponent present all data about the groundwater under 1,500 feet in one place. If these 5 holes (DH 6349, DH 8417, DH 11531, DDH 11535 and DDH 12551) are the sum total of all deep drillhole information, then USACE/project proponent needs to collect more information to properly characterize groundwater under 1,500 feet.
Groundwater	Schlumberger 2011a Appendix 8.1K	2.3 Piezometric Levels	Pg. 4 PDF Pg. 2299	*"From 3,700 feet to 4050 ft bgs (below ground surface) the gradient is upwards"*	This means there are connections between these lower aquifers. NMFS recommends USACE/project proponent explain the hydrologic properties and extent of these deep aquifers, including identifying whether they are connected to Mulchatna River or Lake Iliamna.
Groundwater Temperature	Schlumberger 2011a Appendix 8.1K	2.4 Temperature Distribution	Pg. 4 PDF Pg. 2299	*"The temperature recorded at 1,500 feet depth was approximately 17 degrees Celsius and at 4000 ft it was 35 degrees C."*	NMFS recommends USACE/project proponent provide a list of temperatures and, when available, DO levels for water at depths greater than 1,000 feet. Explain what this information says about the age of the water. Was any of this water isotope dated?
Groundwater	Schlumberger 2011a Appendix 8.1K	3.12 Cross Hole Test #9 - Drilling and Flushing	Pg. 21 PDF pg. 2316	*"DH 8417 - Below 3,857 feet the recovered core was mostly faulted and broken. Shortly after drilling started, most of the probes showed a pressure increase as shown in Figures 3.33 and 3.34."*	USACE/project proponents keep insisting that there is component bedrock down deep and water will not move. DH #8417 is proof that this is a major oversimplification. If the 78-year plan is constructed, mining actions will move into these uncharacterized depths. NMFS recommends USACE/project proponent present a clearer understanding of the aquifers between 1,500 and 3,500 feet so major sources of previously unknown water aren't just stumbled upon. This could quickly present a situation where the water treatment plants are overwhelmed, or where contaminated pit water started moving through these lower layers towards the Mulchatna or the Nushagak.
Faults	Schlumberger 2011a Appendix 8.1K	4.0 Cross Hole Tests Analysis - Introduction	Pg. 23 PDF Pg. 2318	*The flow regime within the bedrock affected by the cross-hole test activities is assumed to be influenced by a network of fractures and/or faults . The majority of the groundwater flows along the fractures.*	NMFS agrees the majority of groundwater flows along the fractures. Why is it so difficult to locate information about these fractures? Why in the 9 years since this was published has very little new information been collected about deep faults? NMFS recommends USACE/project proponent provide a chapter focused on any fractures, faults, or joints that would intersect the current designed pit or the deeper pit design in the 78-year plan. NMFS suggests USACE/project proponent collect all further information needed in order to accomplish this task.
Groundwater	Schlumberger 2011a Appendix 8.1K	4.2.8 Multilevel Groundwater Monitoring System	Pg. 26 PDF Pg. 2321	*HGU 6 is a relatively permeable unit below fault ZEc and is interpreted to lie between 2,990 and 3350 in WB-1 and 3,240 and 3,600 ft in DH-8417.*	NMFS recommends USACE/project proponent determine the spatial extent, tilt, and hydrologic/hydraulic properties of the HGU #6 layer by drilling more deep holes outside the immediate vicinity. The concept that Lake Iliamna and Kvichak Watershed can be protected without understanding this permeable unit is not correct.

Topic	Document & Chapter	Section # Section Title	Page # Figure #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Faults	Schlumberger 2011a Appendix 8.1K	4.2.8 Multilevel Groundwater Monitoring System	Pg. 26 PDF Pg. 2321	*"At a drill depth of approximately 3,240 feet while the drilling test zone #7 there was a sudden mud loss, then an artesian response. ... This is approximately the depth that DH 8417 passes through the ZEc fault."*	Why does the DEIS say the deep faults are barriers to water movement filled with fault grout when fault ZEc had an artesian response? How many other drill holes intersected this fault and what was there an artesian response? How likely is it that there are additional faults that the drill holes simply did not hit? What density of deep holes need to be drilled to even know what faults/fractures exist in an area this size? NMFS recommends USACE/ project proponent present the study design for how they gather knowledge about faults and how confident they are that important water-moving faults have not been overlooked.

Topic	Document & Chapter	Section # Section Title	Page # Figure #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Environmental Baseline Studies Report (2002 - 2008) 15.1 Fish - Mine Study Area					
Salmon Distribution Survey Methods Upwelling	Environmental Baseline Document (2004-2008) Chapter 15	15.1.5.2 Fish Assemblage Surveys - Fish Distribution and Relative Abundance Surveys	Pg. 15.1-12	*"The 2004 through 2008 surveys document patterns of fish distribution, relative fish abundance, and fish density among habitat types (e.g., pool, riffle, run, etc.) within the NFK, SFK, and UT watersheds, and within the upper KR mainstem. Over the 5 years of study, there were 2,850 sampling units (discrete areas where fish were sampled) that were surveyed using a variety of fish sampling methods."*	Early-on project adult fish distributions are documented. However, the number of out-migrating juveniles is highly dependent on the habitat and water available to fish for rearing and spawning. Naturally occurring upwelling areas are important to salmon. Upwelling areas lack delineation within the project's footprint and future scenarios. NMFS recommends USACE/project proponent inventory and delineate upwelling areas throughout the foreseeable project effects area.
Salmon Distribution Survey Methods	Environmental Baseline Document (2004-2008) Chapter 15	15.1.5.2 Fish Assemblage Surveys - Fish Distribution and Relative Abundance Surveys	Pg. 15.1-12	*"The 2004 through 2008 surveys document patterns of fish distribution, relative fish abundance, and fish density among habitat types (e.g., pool, riffle, run, etc.) within the NFK, SFK, and UT watersheds, and within the upper KR mainstem. Over the 5 years of study, there were 2,850 sampling units (discrete areas where fish were sampled) that were surveyed using a variety of fish sampling methods."*	NMFS recommends more consistent and defensible fish survey methods be used to document fish distributions (Johnson 2007, PLP-Technical Working Groups 2009, Parsons 2010).
Salmon Distribution Survey Methods	Environmental Baseline Document (2004-2008) Chapter 15	15.1.5.2 Fish Assemblage Surveys - Fish Distribution and Relative Abundance Surveys, Adult Salmon Surveys	Pg. 15.1-12 Pg. 15.1-14 Pg. 15.1-14	*"The 2004 through 2008 surveys document patterns of fish distribution, relative fish abundance, and fish density among habitat types (e.g., pool, riffle, run, etc.) within the NFK, SFK, and UT watersheds, and within the upper KR mainstem. Over the 5 years of study, there were 2,850 sampling units (discrete areas where fish were sampled) that were surveyed using a variety of fish sampling methods."* *"For these reasons, a mean index count analysis, rather than an escapement analysis, was used to evaluate adult salmon abundance over the study period and among watersheds. Index counts refer to the number of adult salmon observed on a given survey date. Annual mean index counts were calculated for each species by determining the mean of the index counts across the number of survey dates on which a species was observed. The subset of survey data included in the mean index count analysis was selected to allow for comparison of species-specific counts across watersheds and years. Thus, index counts from river reaches that were most consistently surveyed over the 5-year study period were used in the analysis. In order to maintain rigor in the analysis, it was also important to maximize the number of surveys included therein. Several surveys each year covered extended stream lengths and data within could not be parsed out by location; therefore, some variation in endpoints was allowed when selecting surveys for index counts. Surveys included by watershed are listed below.* • *NFK—61 complete surveys that started at the confluence with the Koktuli River and ended near Big Wiggly Lake or at River Mile (RM) 34.78 (River Kilometer [RK] 55.98)* • *SFK—67 complete surveys that started at the confluence with the Koktuli River and ended at the intermittent reach or at Frying Pan Lake* • *UT—51 complete surveys that started at the mouth of the UT and ended at the confluence of Tributary 1.350 or at the headwaters"*	NOAA Fisheries attended meetings from 2004 to 2007 and provided survey suggestions. Those recommendations remain valid today (2019): 1) What is the total adult salmon escapement in headwater tributaries? 2) What is the full range and distribution of emergent salmon fry, young of the year, age 1, and age 2 year old salmon? 3) What are the specific EFH attributes that support these early life history rearing phases? NMFS recommends the project proponent complete or provide the following information: 1) Conduct tower, sonar or weir counts (Parsons 2010, ADFG, Johnson 2007) to determine accurate (total) adult escapement; 2) Design a repeatable series of surveys and sampling protocols to specifically identify YOY and Age-1 salmon distributions; 3) Identify/ delineate known habitat areas that support salmon early life history stages in the mainstem rivers and the tributaries.
Salmon Distribution Survey Methods	Environmental Baseline Document (2004-2008) Chapter 15	15.1.5.3 Instream Flow Habitat Studies - Mainstem Channel Flow Habitat Studies	Pg. 15.1-17	*"The hydraulic models were subsequently linked with Habitat Suitability Criteria (HSC) curves that represent the suitability of selected parameters (depth, velocity, and substrate/cover) for use by different life stages of the target fish species. The HSC curves for some species and life stages were based on existing literature-derived curves, while for others, field data were collected and site-specific HSC curves developed (Photo 15.1-7). The site-specific data consisted of depth, velocity, and substrate measurements made directly at observed fish locations as noted during snorkel surveys, as well as measurements made at distinct redds that represented spawning areas."*	The data listed in this section is not properly cited. At a minimum, NMFS requests USACE/project proponent present data and informtaion sources that reflects the area, or areas, where the data was collected and analyzed.
Salmon Distribution PHABSIMS	Environmental Baseline Document (2004-2008) Chapter 15	15.1.5.3 Instream Flow Habitat Studies - Mainstem Channel Flow Habitat Studies	Pg. 15.1-19	*"This approach resulted in the establishment of 92 transects, corresponding to 21 transects in the NFK, 28 in the SFK, 32 in the UT, five in the upper KR mainstem and six in the Tributary UT1.190"*	PHABSIM is an older method that has some strengths and some well-documented drawbacks. It appears the project proponent established transects primarily in the 3 mainstem rivers. The 30 transects per mainstem river that were surveyed are in line with general practice sample sizes. However, Pebble mine is likely to impact a dozen or more tributary streams. It appears the project proponent established no transects in tributaries of SFK and NFK and only six studies in the tributary UT1.190. Many of these tributaries are improtant to fish and PHABSIM should have been applied equally rigorously to these tributaries. NMFS is not suggesting every tributary needed 25 transects, but perhaps 25 per watershed, or divided by other relevant criteria, but habitat in tributaries definitely needs to be characterized. NMFS recommends the USACE/project proponent thoroughly apply the PHABSIMs to the tributary streams and combine this work with Habitat Suitability Curves developed around a range of EFH attributes including upwelling. Without such an analysis, the project proponent's statement in the EFH assessment that there is little/no habitat in tributaries is unsubstantiated.
Salmon Distribution PHABSIMS	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6 Results and Discussion (NFK, SFK, UTC, KRM)	Pg. 15.1-29 Pg. 15.1-33 Pg. 15.1-41	*"Surface water expression of groundwater can provide considerable benefits to spawning and rearing fish."* *"Chum salmon are known to seek spawning areas influenced by groundwater upwelling"* *"...a direct association between spawning area and areas identified as gaining reaches due to inflow form groundwater, seeps, or springs was evident."*	This section under represents the important role of groundwater expressed through upwelling hyporheic substrates, seeps and springs. The Environmental Baseline Document, Chapter 15, in over 30 places discusses this important EFH Attribute. NMFS requests the USACE reference Chapter 15 and better represent the role groundwater plays to fresh water phase salmon.

Topic	Document & Chapter	Section # Section Title	Page # Figure #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Groundwater Upwelling	Environmental Baseline Document (2004-2008) Chapter 15	15.1.1.1 Regional Description - Geology	Pg. 15.1-5	*"Moraine and glacial drift deposits are also relatively porous and may contain numerous surface kettle ponds that drain to groundwater. The high storage capacity of the thick surficial materials, and to a lesser extent the surface ponds, in the study area attenuates high flows during wet periods and helps maintain base flows during dry periods."*	Adding surface water back into tributary channels is unlikely to restore upwelling, hyporheic flows, or kettle ponds. Upwelling areas are important to salmon spawning. Kettle ponds provide juvenile (fry) habitat if they are connected to streams, even if occasionally during large rainstorm events. The applicants do not offer much discussion on this. NMFS recommends USACE/project proponents document which kettle ponds and tiny intermittent streams provide juvenile or fry habitat.
Environmental Baseline Studies Report (2002 - 2008) Fish and Aquatic Invertebrates North Fork Koktuli Watershed					
NFK	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.1 Results and Discussion - North Fork Koktuli Watershed	Pg. 15.1-30	*"Because no data are available to assess the relative contribution of these NFK fish to the fisheries, district-scale data are provided here as an indication of the importance of these fisheries. Based on a 20-year average (1988 through 2007), the annual commercial harvest for the overall Nushagak District was 52,190 Chinook, 476,508 chum, 28,660 coho, and 4,969,524 sockeye salmon (Jones et al., 2009). Over the same period, the average annual subsistence harvest for the overall Nushagak District was 13,047 Chinook, 4,461 chum, 5,420 coho, and 26,421 sockeye salmon."*	NMFS suggests USACE/project proponent supply the data necessary to assess the relative abundance of salmon stocks affected within the project area and also downstream.
NFK Upwelling	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.1 Results and Discussion - North Fork Koktuli Watershed	Pg. 15.1-42	*"Within the NFK, NFK-C and NFK-D had the most diverse species assemblages, and NFK-C and Tributary NFK 1.190 supported the highest relative abundance of the fishes documented over the study period. The abundance and diversity of fish in NFK-C did not appear to be driven by habitat availability. As predicted by the instream-flow model, NFK-B should provide much more available habitat for all juvenile salmonids except rainbow trout, and the highest estimates of available spawning habitat for four out of seven salmonids was in NFK-A. The habitat quality in NFK-C may be a factor influencing the richness of fish species. NFK-C gained inflow from Tributary 1.190, as well numerous seeps and springs located along the mainstem channel margin (Chapter 9, Section 9.1). Tributary 1.190 was also largely influenced by seeps and springs and contributed cooler water to NFK-C, providing an enhanced thermal regime to habitats downstream compared to those upstream in NFK-D, NFK-E, and NFK-F."*	NMFS notes the applicant's acknowledgement that habitat in the NFK-C and Tributary 1.190 are areas of high habitat quality, including upwelling areas (springs). The re-occurring run strengths in all reaches indicate temperatures are adequate to support reproduction and egg incubation. NMFS recommends the project proponent revisit the Habitat Suitability Curves (HSC); because if NFK-C and NFK 1.190 have the most salmon abundance it suggests there is something unique about the habitat. The current HSC does not capture this. The presence of seeps and springs is not a coincidence. As stated in a previous section, though recognizing altering temperatures will have cumulative impacts on early salmon life histories, there is little description of how the USACE/Project Proponents intent to mitigate these impacts. An analysis should be conducted to address the cumulative impacts of water temperature changes such as timing, size at emergence and changes in food chain dynamics in these watersheds. Then real mitigation measures should be designed to reduce these cumulative impacts in the tributary reaches where water and salmon are still present (Beacham and Murray 1990, Webb and McLay 1996, McCullough 1999, Brannon et al. 2004, Neuheimer and Taggart 2007, Fuhruman et al. 2018, Adelfio et al. 2019).
Environmental Baseline Studies Report (2002 - 2008) Fish and Aquatic Invertebrates South Fork Koktuli Watershed					
SFK Upwelling	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.2 Results and Discussion - South Fork Koktuli Watershed	Pg. 15.1-48	*"No results are displayed for SFK-D and SFK-E, because transects were not established in those reaches. SFK-D is located directly below Frying Pan Lake and contains comparatively little spawning habitat. SFK-E extends above Frying Pan Lake and there have been relatively few anadromous salmonids found in this reach."*	NMFS suggests USACE/project proponent supply upwelling data for the area above Frying Pan Lake. NMFS also recommends the project proponent use minnow traps to quantify the juvenile fish in these reaches.
SFK Salmon Distribution	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.2 Results and Discussion - South Fork Koktuli Watershed	Pg. 15.1-50	*"However, limited observations of juvenile coho salmon and sockeye salmon in the lake indicate this habitat may have some potential for rearing. Surface water impoundments like Frying Pan Lake and nearby ponds also provide habitat for other stream-dwelling fishes and provide water storage and extended surface water runoff volumes late in the summer period compared to watersheds without such storage."*	Observations seems to be arbitrary; no site specific data or transects are cited. NMFS suggests USACE/project proponent supply this data.
SFK Salmon Distribution Groundwater	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.2 Results and Discussion - South Fork Koktuli Watershed	Pg.15.1-49 Pg. 15.1-50	*"Seeps and Springs. A comprehensive survey of seeps and springs in the SFK was performed in 2005 and 2006, and the surface water expression of these features was plotted in Figure 9.1-4 of Chapter 9, Section 9.1. There was a large concentration of seeps and springs upstream of Frying Pan Lake and in the central portion of the SFK, along the upper portion of SFK-B. Seeps and springs add to river flow and moderate stream temperatures in both summer and winter…"*	NMFS notes the large number of seeps and springs in and above Frying Pan Lake. However, no salmon investigations in the lake or upstream areas were conducted. Therefore, NMFS finds it difficult to assess salmon presence/absence, rearing, or spawning activities in these areas. NMFS recommends the project conduct juvenile salmon abundance surveys in the lake and areas upstream.
EFH Attribute Surface Water Groundwater	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.2 Results and Discussion - South Fork Koktuli Watershed	Page 15.1-51	*"Velocity Shelter. A general lack of mainstem channel pool habitat, instream cover features, and large woody debris in the SFK results in a lack of velocity shelter for rearing fishes. This condition suggests juvenile rearing may need to rely on off-channel habitats, especially for winter refuge when water temperature and stream flow become quite low. The lack of juvenile winter rearing habitat is evident in the instream flow habitat duration curves (Figure 15.1-47)."*	NMFS notes winter conditions include low water regimes. Upwelling waters become highly important to ensure water is present for eggs and juveniles. Upwelling may also keep off-channel sloughs from freezing and provide juvenile rearing habitat. Winter habitat does exist, otherwise salmon runs would not. The project cannot mitigate impacts to this habitat if they are not sure where it is. NMFS recommends that the project complete winter surveys (such as trapping) and habitats used by fish, including tributaries and off-channel slough areas.
SFK EFH Attribute Surface Water Groundwater	Environmental Baseline Document (2004-2008) Chapter 15	15.1.6.2 Results and Discussion - South Fork Koktuli Watershed	Page 15.1-52	*"Surface water expression of groundwater can provide considerable benefits to spawning and rearing fish. The distribution of zones of observable groundwater influence is limited to gaining reaches in SFK-A and throughout most of SFK-B. Fish abundance and productivity might be reduced in other locations with lower input of groundwater. As an example, salmon spawning is restricted upstream of SFK-B (Appendix 15.1B, Figures B.9-10, B.9-11, B.9-12, and B.9-13). This location is upstream of the zone of major groundwater influx to surface waters in the reach."*	The dewatering of salmon streams will contribute to the loss of salmon in that reach. Salmon productivity will be eliminated. Salmon stocks historically available to feed the local economy will also endure loss. NMFS recommends USACE/project proponent to update their EFH Assessment to reflect this devastating impact.
Environmental Baseline Studies Report (2002-2008) Appendix 15.1C - Instream Flow: Main Channel Habitat Study					

Topic	Document & Chapter	Section # Section Title	Page # Figure #	*Author's Original Language or Description of Citation*	NMFS Recommendations for USACE/Project Proponent.
Groundwater Model Upwelling	Environmental Baseline Document (2004-2008) Appendix 15.1C	1.1.2 Flow Related Effects on Fish Resources	Pg. 3	*"Changes in flow magnitude will change the amount of spawning and rearing habitats in a stream… the amounts of habitat will increase with flow up to a certain point, and then begin to decrease as velocities exceed those used by adults for spawning and juveniles and fry for rearing.".*	NMFS advises the USACE to re-assess water site velocity as the primary condition for salmon. Upwelling and lateral groundwater flow are found to be extremely important factors in salmon rearing and survival. Velocity alone will yield inadequate model results (Reynolds 1997, Winter et al. 1998, Waddle 2001, Stanford et al. 2005, Mouw et al. 2013). There are several scientifically peer reviewed papers that suggest PHABSIM models based on instream flow velocity no longer represent our current understanding of the other EFH attributes that support early freshwater life stage salmon (Maclean 2003, Mouw et al. 2014, Railsback 2016).
Salmon Distribution Survey Methods	Environmental Baseline Document (2004-2008) Appendix 15.1C	3.4 Habitat Suitability Criteria Curve Development	Pg. 26	*"HSC curves are a required element for defining habitat-flow relationships. HSC reflect species and lifestage use and preference for selected habitat parameters (depth, velocity, and substrate; Bovee, 1982, 1986). Depending on the extent of data available, HSC curves can be developed from the literature (Category 1 curves), or from physical and hydraulic measurements made in the field over species microhabitats (Category 2 curves). When adjusted for the availability of habitat, the curves may more accurately reflect species preference (Category 3 curves) as described in Bovee (1986)."*	This section is erroneous and does not apply to salmon stocks in Alaska. The methods are dated, developed from literature (limited site data used), and is more representative of trout and endangered salmon stocks in the Pacific Northwest. NMFS recommends the project proponent develop habitat suitability criteria based on species that are actually present in the project area.
Salmon Distribution Survey Methods	Environmental Baseline Document (2004-2008) Appendix 15.1C	3.4 Habitat Suitability Criteria Curve Development	Pg. 26	*"HSC curves are a required element for defining habitat-flow relationships. HSC reflect species and lifestage use and preference for selected habitat parameters (depth, velocity, and substrate; Bovee, 1982, 1986). Depending on the extent of data available, HSC curves can be developed from the literature (Category 1 curves), or from physical and hydraulic measurements made in the field over species microhabitats (Category 2 curves). When adjusted for the availability of habitat, the curves may more accurately reflect species preference (Category 3 curves) as described in Bovee (1986)."*	The degree of impact on EFH from an action can only be determined when the importance or the role of the EFH attributes is accurately identified. Data needs to be collected and analyzed from areas of fish presence and absence and state whether salmon are occurring there or not. Questions: Why do fish select a certain site? What were the conditions compared to a site that is not used? How do conditions differ? For example, correlations exist for salmon spawning site selection (temperature, springs, substrates)? Is there a correlation between groundwater upwelling temperature and spawning distribution? If these influences were removed, how would that influence spawning site selection? NMFS recommends the project proponent fully characterize the presence and absence of salmon in areas, whether or not they are frequently used for spawning, rearing or as migration corridors. NMFS recommends the project proponent clarify and describe the role upwelling, temperature and substrates play as improtant EFH attributes.
Environmental Baseline Studies Report (2002-2008) Appendix 15.1D - OFF-CHANNEL HABITATS					
EFH Attribute Surface Water Groundwater Off-Channel Habitats Extent of Impacts	Environmental Baseline Document (2004-2008) Appendix 15.1D	1.2 Overview of OCH Formation and Fish Habitat Function	Pg. 2	*"OCHs in glaciated river valleys are created by the interaction of channel processes, ground and surface water, vegetation, and beaver activity. The continuous interaction of all of these elements, especially channel migration and beaver activity, results in a dynamic floodplain environment within which OCHs are continually being created and destroyed. The locations (connections with mainstem rivers), morphologies (typically slow moving, relatively deep water), and complexities (often contain a mix of woody debris and aquatic vegetation) of many types of OCHs make them especially attractive as refuge and rearing habitats for juvenile salmonids."*	NMFS agrees with the assessment that many different environmental elements are needed to contribute healthy habitat, e.g. "the continuous interaction of all of these elements", "connections with mainstem rivers and morphologies", and "complexity, make them especially attractive as refuge and rearing habitats for juvenile salmonids". NMFS advises the project proponent to carefully consider and assess how dewatering the project area will affect complex matrix of environmental factors.
EFH Attribute Groundwater Off-Channel Habitats Extent of Impacts	Environmental Baseline Document (2004-2008) Appendix 15.1D	1.2 Overview of OCH Formation and Fish Habitat Function	Pg. 2	*"Groundwater within these systems appears to be important to the generation and maintenance of OCHs and may also affect their potential to function as high quality fish habitat. Groundwater-controlled OCHs include isolated ponds, percolation channels, and beaver ponds. These OCHs contain water year-round and under varying flow conditions; they also may provide a continuous source of water to mainstem habitats. Surface water connectivity between OCHs and the mainstem is the critical element in providing fish access from the mainstem to and from off-channel habitat (Pollock et al., 2004)."*	NMFS agrees that groundwater quality and availability are important to fish. NMFS finds no evidence in literature or in the provided reports to support the idea that the extent of groundwater loss would allow for the continued use of these areas for salmon. Technologies may exist to re-introduce water back into dewatered areas. To do so in a manner that returns fish habitat to a state that is conducive to sustain healthy, productive salmon populations is not discussed. If such technologies exists, the project proponent has not suggested they will pursue them. NMFS is skeptical returned water to the streams (or groundwater) will be similar to the pre-project, pristine water quality conditions needed for salmon. NMFS can locate many studies and research that groundwater and upwelling areas are critical to maintain healthy habitat conditions for fish. Dewatering of these areas over the life of the project would be catastrophic to future salmon populations. NMFS recommends the project proponent explain how they intend to return groundwater to the project area in a way that will restore salmon EFH and sustain salmon.
Survey Methods Off-Channel Habitats Salmon Distribution	Environmental Baseline Document (2004-2008) Appendix 15.1D	Section 5.7 Fish Sampling	Pg. 8	*"Off-channel sites were sampled between early summer and early fall, with specific sampling months varying between watersheds and years. In the SFK watershed, fish sampling occurred in September 2005, June and August 2006, and July 2007 (Figure 7). The UT sites (Figure 8a and 8b) were sampled in July and October 2007, and the off-channel sites in the NFK (Figure 9) were sampled between late July and mid-August 2008.*	NMFS finds it difficult to assess the methods, usefulness of the sparse data, and the periodic use sampling events. Also, the data sets are now more than 12 years old. Off-channel reaches play an important role to the rearing of juvenile salmon. NMFS recommends the project proponent utilize sampling observations and locations that are repeatable and represent all-seasons.
Survey Methods Off-Channel Habitats Salmon Distribution	Environmental Baseline Document (2004-2008) Appendix 15.1D	Section 6.6 Fish Sampling	Pg. 11	*"…Four species of anadromous salmonids (coho salmon, sockeye salmon, Chinook salmon, and chum salmon). …Juvenile coho densities by OCH type were as high as 234.04 fish/m2 as observed in one alcove area in the NFK. Sockeye salmon fry were the second-most commonly found anadromous species throughout the study area, with densities as high as 4.34 fish/100 m2 calculated for alcove in the NFK. Comparatively few Chinook (0.01 to 7.74 fish/100 m2) and chum salmon (0.05 fish/100 m2) were found throughout the study area".*	NMFS acknowledges the applicant's study efforts, but concludes these efforts are limited, sparse, lack scientific rigor, and do not fully assess all salmon life stages. NMFS recommends the project proponent perform standardized, repeatable, year-round studies at specific locations and these studies be made readily available for review. Without more detailed and thoughtfully collected data about the salmon use in the project area, NMFS will continue to find it difficult to assess the potential loss of salmon as a sustainable stock and local resource.

TOPIC	CHAPTER	SECTION	PAGE	*AUTHORS ORIGINAL LANGUAGE*	COMMENT
APPENDIX H - ESA BIOLOGICAL ASSESSMENT - NMFS					BA does not take into account indirect project effects, including increased ship traffic through listed species range and through critical habitat, as well as possible reductions in prey availability, especially reduced availability of salmon to Cook Inlet belugas due to disruption/destruction of intact salmon spawning streams. While we recognise that these issues lie outside of COE authority, examination of all effects of the permitted project (and disclosure of project effects on listed species) is needed in order to conduct an ESA S7 jeopardy analysis.
	2	2.2	4	*The Action Area for the causeway and wharf construction is based on in-water construction activities and the underwater acoustical footprint due to in water impact pile driving to the 160-decibel (dB) sound pressure level (SPL) isopleth and vibratory pile driving and fill placement to the 120-dB SPL isopleth.*	COE determined action area for those parts of the project over which they have authority, and not for the entire project. This is inconsistent with the definition for Action Area: "Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this reason, the action area is typically larger than the project area and extends out to a point where no measurable effects from the proposed action occur.
	2	2.2	6	*The short-term disturbance associated with drilling a few anchor holes does not rise to the level of take.*	Unclear whether they are talking about noise or substrate disturbance. If noise, please provide sound source levels for this activity.
	4	4.3.4	14	*beluga whale use of Area 2 habitat as far south as the Action Area has not occurred in recent years (Rugh et al. 2010, Shelden et al. 2017)*	Misleading. More correct to say beluga use of this area has not been documented. We do not know that such use has not occurred as there is very little observer effort expended in this area.
	5	5	18	*Incidental spills of petroleum lubricants and fuels from fueling and operation of construction equipment*	Consequences of proposed action does not take into account any activities associated with operation of the mine, only with construction of in-water infrastructure. This is too narow of a scope of analysis for project effects, and does not account for any indirect effects that would not occur but for these construction activities (such as spills of chemical reagents or non-construction vessel traffic in the future)
	5	5.1.1	19	*However, NMFS has recently determined that vessel noise impacts from the operation of tug thrusters and propellers are discountable (83 FR 7655)*	83 FR 7655 is an IHA proposal for a wind energy project in New York state. It does not represent NMFS national policy. This information is presented in a misleading way, causing the reader to assume that the citation refers to NMFS policy statements. There are many factors that could result in different conclusions being drawn regarding activities for these two very different projects in very different environments affecting entirely different species. In addition, the project referred to in the application had not undergone ESA section 7 consultation or public comment at the time of publication.
	5				No consideration given to sound associated with Anchor Handling during pipeline construction and other activities
	5	5.1.4	20	*Finally, NMFS has recently published that harassment associated with construction vessel noise (83 FR 7655) is discountable*	83 FR 7655 is an IHA proposal for a wind energy project in New York state. It does not represent NMFS national policy. This information is presented in a misleading way, causing the reader to assume that the citation refers to NMFS policy statements. There are many factors that could result in different conclusions being drawn regarding activities for these two very different projects in very different environments affecting entirely different species. In addition, the project referred to in the application had not undergone ESA section 7 consultation or public comment at the time of publication.
	5	5.1.4	21	*NMFS has recently published (see 83 FR 7655) that these noise levels are similar to those of transiting vessels, rarely result in marine mammal response, and the likelihood of thruster use resulting in harassment take to be low to the point of discountable.*	83 FR 7655 is an IHA proposal for a wind energy project in New York state. It does not represent NMFS national policy. This information is presented in a misleading way, causing the reader to assume that the citation refers to NMFS policy statements. There are many factors that could result in different conclusions being drawn regarding activities for these two very different projects in very different environments affecting entirely different species. In addition, the project referred to in the application had not undergone ESA section 7 consultation or public comment at the time of publication.
	5	5.3	23		There is no consideration of entanglement of Cook Inlet beluga whales or Steller sea lions in marine debris. Please include this information.
	6	6.2	26	*The plan will include the use of noise attenuating devices as required, such as bubble curtains, ramp up procedures (soft-start), and establishing both shutdown safety zones (to avoid Level A take) and monitoring zones (to document Level B take)*	It is incumbent upon the corps to implement measures that not only document level B take of marine mammals, but to minimize any take of ESA listed species (not merely to document such take).

TOPIC	CHAPTER	SECTION	PAGE	*AUTHORS ORIGINAL LANGUAGE*	COMMENT
	6	6.2	Measure 6 page 26	*Note that during the 1-hour break for a PSO, a crew member can be assigned to be the observer as long as they do not have other duties at that time and they have received instructions and tools to allow them to make marine mammal observations.*	Past approved use of crew members as PSO's has been specific to specific activities, and is not intended to be a measure that applies equally to all PSO duties. For example, NMFS would not approve crew to serve as PSOs on a seismic exploration project while air gun arrays are in operation.
pile driving	6	6.2	Measures 18, 20, and 21, page 28	*If visibility degrades to less than 984 ft (300 m) during pile driving, pile driving of the section of sheet pile that was being driven when visibility fell below 984 ft (300 m) may continue to the target depth of that sheet pile but will not drive additional sections of piling. If pile driving is suspended (to weld on a new section, for example) when the monitoring zone is not visible, pile driving will not resume until visibility exceeds 984 ft (300 m) and the PSO has indicated that the zone has remained devoid of marine mammals for 30 minutes prior to additional pile driving.*	This measure is specific to sheet pile, but should be generalized to include all piles. It is not clear from where the distance 984 ft. (300 m) is derived. This distance should be equal to or greater than the outer limits of the level B zone for each activity.
Take	6	6.2	measure 28, page 29		This measure was block copied from an LOC. Make sure it states what you wish it to state.
Sound	7	7.1.1	31	*As mentioned in Section 2.2, harassment-level disturbance (exceeding 160 dB SPL) can extend from a few hundred feet to a couple of miles*	the 160 dB sound isopleth for harassment applies only to impulsive sound. The 120 db isopleth applies to non-impulsive sound
Vessel Strike	7	7.1.2	31	*While it is important to note that humpback whales comprise most vessel strike records in Alaska (Neilson et al. 2012), the risk of strike in the Action Area is low to the point of discountable because of the low (<10 kt [18.5 km/hr]) travel speed of the vessels involved. Therefore, the determination is No Effect.*	discountable probability of effect does not automatically lead to determinations of no effect. More typically, it results in a determination of not likely to adversely affect. This comment carries through to subsequent species in subsequent sections of Direct Effects.
Entanglement	7	7.1.3	31	*The exact risk of entanglement is unknown but is considered discountable given no rope will be used. Therefore, the determination is No Effect.*	discountable probability of effect does not automatically lead to determinations of no effect.. More typically, it results in a determination of not likely to adversely affect. This comment carries through to subsequent species in subsequent sections of Direct Effects.
Spills	7	7.1.4	32	*The required operation safeguards would minimize the occurrence of spills, size, and extent. Potential incidental spills in Kamishak Bay and Cook Inlet would quickly dissipate in the water due to the high flushing rate of Cook Inlet waters. The determination is No Effect.*	Rapid dissipation of spilled product does not lead to a determination of no effect. It is unclear how the Corps arrived at this determination. This comment carries through to subsequent species in subsequent sections of Direct Effects.
Spills	8		36		There is no consideration given to the spill risk associated with the transfer of chemical reagents
Effects Determinations	10	Table 4	38		Most or all of the **No Effect** determinations would be more appropriately labeled **Not Likely to Adversely Affect. Some are arguably Likely to adversely affect determinations, such as the effects of noise on beluga whales. Also, Table 4 makes some nonsensical determinations, such as the determination that critical habitat will have no effect upon beluga whales or Steller sea lions.**
DEIS EXECUTIVE SUMMARY					
Physical Site Closure	0	1	12		No indication provided regarding safeguards to be put in place to assure that physical site closure occurs.
Physical Site Closure	0	1	13		No indication provided regarding safeguards to be put in place to assure that natural gas pipeline removal/reclamation will occur.
fish passage	0	1	9		A description of fish passage culvert design (beyond "in accordance with regulatory standards) should be provided.
Physical Site Closure	0	1	20		In AA2, pile-supported dock variant, no indicationn given to the proposed timing of pile driving for the 518 48 inch piles.
Beluga whales	0	1	31	*With the exception of past Cook Inlet beluga whale subsistence overharvest effects on population levels, effects of past and present commercial fishing and recreational harvest of fish and wildlife have been minimal.*	The Execitive Summary mentions beluga whales only once, and does not mention potential project impacts upon this endangered species in decline at all.
Spilled reagents	0	1	66	*potential spills of natural gas and chemical reagents were deemed to be ...of low impact*	Page 69 (3.5.6) indicates that analysing the environmental impacts of spilled reagents was determined to be unnecessary in the EIS

TOPIC	CHAPTER	SECTION	PAGE	*AUTHORS ORIGINAL LANGUAGE*	COMMENT
Steller sea lions	0	1	??	*Impacts (of diesel spills) to marine mammals would be of low likelihood and temporary; individuals or groups could potentially be injured or die, but population-level effects are unlikely.*	toxicity to SSL pups if rookeries are contaminated.
Draft EIS chapter 4					
4.25 Threatened and Endangered Species			4.25-1-2		Analysis does not seem to include the zone within which vessel noise (e.g. tugs) exceeds 120 dB SPL isopleth for continuous noise.
4.25 Threatened and Endangered Species			4.25-6	*Based on the short duration of potential exposure to vessel- or aircraft-related noise and visual disturbance, it is expected that any effects on Cook Inlet beluga whales would be limited to brief behavioral responses such as reducing surface time and diving. Vessel and aircraft presence concurrent with the presence of beluga whales would be short-lived, and only temporary effects on Cook Inlet beluga whales are expected.*	At nearly 300 trips per month for lightering vessels transporting concentrate throughout the life of the project, it is hard to reconcile the notion of brief behavioral responses causing only temporary effects. In aggregate, the effects would not seem to be merely temporary.
4.25 Threatened and Endangered Species			4.25-11	*There were 93 reports of humpback whale-vessel collisions in Alaska waters between 1978 and 2011, with only one confirmed record in upper Cook Inlet (Neilson et al. 2012). Between 2008 and 2012, the mean minimum annual human-caused mortality and serious injury rate for humpback whales, based on vessel collisions in Alaska, was 0.45 whale per year, as reported in the NMFS Alaska Regional Office stranding database (Allen and Angliss 2015).*	This information needs to be updated to reflect best available information.
4.25 Threatened and Endangered Species			4.25-7	*The magnitude and extent of permanent direct impacts would be the placement of fill in approximately 10.7 acres of designated Cook Inlet beluga whale critical habitat for construction of the port; 11.5 acres of critical habitat would be temporarily impacted during installation of the natural gas pipeline. Under the Pile-Supported Dock Variant, the magnitude and extent of impacts would be the placement of fill in 0.07 acres of Cook Inlet beluga critical habitat to construct the dock. These acreages were calculated based on the area of critical habitat (derived from USFWS geographic information system layers) that overlaps with project components, and occurs below mean high higher water levels (MHHW).*	It is inappropriate to use USFWS' GIS layers for a NMFS-managed species.
4.25 Threatened and Endangered Species		Table 4.25-2	4.25-8	*None, the lightering locations are outside of critical habitat for all TES.*	Misleading statement and inadequate analysis of lightering upon beluga critical habitat. While it is true that lightering mooring locations are outside of beluga critical habitat, actual lightering activities take place largely within beluga critical habitat.
4.25 Threatened and Endangered Species			4.25-15	*If any responses of Steller sea lions associated with aircraft were to occur, they are likely to be short-lived, and therefore are not expected to cause more than a temporary disturbance to Steller sea lions (NMFS 2017a).*	This statement ignores the information presented earlier in the document, where it correctly states that disturbed Steller sea lions may stampede, and in so doing, injure or kill pups.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

June 18, 2019

Col. Phillip Borders
US Army Corps of Engineers, Alaska District
Regulatory Division
PO Box 6898
JBER, Alaska 99506-0898

Dear Colonel Borders:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Endangered Species Act (ESA) Biological Assessment (BA) and Draft Essential Fish Habitat (EFH) Assessment for the proposed Pebble Mine (Appendices H and I of the Draft Environmental Impact Statement, or DEIS), as well as sections of the DEIS relevant to NMFS's trust resources. The project involves the construction and operation of an open pit mine and ancillary facilities, a port facility, access roads, ferry terminals on Iliamna Lake, and a natural gas pipeline. The mine would be located in the Bristol Bay watershed and the port would be in Cook Inlet, with a road and pipeline connecting the two.

At NMFS's request, the U.S. Army Corps of Engineers (Corps) convened a meeting with NMFS and the Pebble Limited Partnership (Pebble) on May 21, 2019, to discuss the forthcoming consultations between our agencies for the Pebble project under section 7 of the ESA and section 305 of the Magnuson-Stevens Fishery Conservation and Management Act. During that meeting, NMFS noted additional information and analysis that will be necessary to support the ESA and EFH consultations, and agreed to summarize these information needs in a letter to the Corps. NMFS also anticipates that Pebble will apply to NMFS for incidental take authorization under section 101(a)(5) of the Marine Mammal Protection Act (MMPA) for those activities that have the potential to "take" marine mammals, so this letter includes comments related to information in the DEIS that could inform that process as well. NMFS anticipates providing more specific comments to the Corps as the interagency review process continues.

ESA Consultation

The draft BA is too narrow in scope to support consultation on the effects of the proposed action on threatened and endangered species under NMFS's jurisdiction, as required by section 7 of the ESA. The draft BA focuses exclusively on effects from the construction of the proposed port facility and pipeline in Cook Inlet, and is silent on potential effects from the construction, operation, and post-closure phase of the Pebble mine, including indirect, interrelated, and interdependent effects. Indirect effects include consequences for ESA-listed species from increased shipping activity associated with the port and from potentially diminished salmon runs (prey for ESA-listed species in Bristol Bay and the eastern Bering Sea) due to either the mine development itself or a breach of the tailings dam. Although the Corps does not have regulatory jurisdiction over shipping, but for the Corps' authorization of mine infrastructure construction,

this increase in shipping would not occur. Likewise, the Corps does not have jurisdiction over the continuing stability of a tailings dam, but a low-probability, high consequence event such as a tailings dam failure would not occur but for the Corps' authorization.

ESA section 7 consultations must assess the effects of all components of a proposed action, including indirect, interrelated, and interdependent effects, to develop a proper analysis of the effects of the action on threatened and endangered species. This approach is consistent with our practice for consultations on other major actions. For example, for actions that require the mobilization of significant amounts of equipment, section 7 consultations routinely consider the risks to endangered marine mammals from vessel strikes by ships and barges travelling to and from the project location. Similarly, section 7 consultations for oil and gas exploration and development routinely consider the risks to listed species from well blowouts or other spills. Thus, the Corps and Pebble should expand the draft BA to consider all reasonably foreseeable effects of the proposed action. For low-probability events, the analysis should discuss the probability and consequences based on the best available information. We suggest that you take a similarly broader view of effects to ESA-listed marine mammals in your final EIS as well.

In addition to broadening the scope of the BA in accordance with section 7 of the ESA, the Corps and Pebble should revisit each of the draft BA's determinations of effects to listed species. The existing draft BA confuses the threshold for a determination of "no effect" versus "not likely to adversely affect" listed species, a determination that is appropriate only when all effects of the proposed action are discountable, insignificant, or beneficial. For example, section 7.1.2 (page 31) of the draft BA states: "*While it is important to note that humpback whales comprise most vessel strike records in Alaska (Neilson et al. 2012), the risk of strike in the Action Area is low to the point of discountable because of the low (<10 kt [18.5 km/hr]) travel speed of the vessels involved. Therefore, the determination is No Effect.*" Effects to listed species from vessel strikes near the port facility might be extremely unlikely to occur, but such effects cannot be ruled out with a "no effect" determination, and should more properly be considered "not likely to adversely affect" listed species. Likewise, page 32 of the draft BA states: "*The required operation safeguards would minimize the occurrence of spills, size, and extent. Potential incidental spills in Kamishak Bay and Cook Inlet would quickly dissipate in the water due to the high flushing rate of Cook Inlet waters. The determination is No Effect.*" Effects from spills near the port facility may be reduced by rapid dissipation reducing the exposure risk to listed species, but this does not remove the effects, and again a determination of "not likely to adversely affect" would be more appropriate. We would be happy to discuss these sorts of distinctions with the Corps and Pebble as needed to help in your revisions of the BA.

EFH Consultation

The draft EFH Assessment generally understates the value of EFH that would be affected by the proposed action and the seriousness of likely adverse effects to EFH and federally managed fish species from the proposed action, and should be revised accordingly. As defined at 50 CFR 600.910, "*Adverse effect means any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH.*

Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions."

The draft EFH Assessment and related sections of the DEIS do not adequately describe the current condition of the ground and surface water regimes in the vicinity of the proposed mine and the role that complex hydrologic processes play in supporting salmon populations. Accurately presenting the current baseline condition is necessary for a thorough analysis of the direct and cumulative impacts from dewatering the project site and adjacent areas while allowing discharges to the downstream waters.

The DEIS and draft EFH Assessment's descriptions of the Pebble project are inconsistent, highly variable, and lack a complete portrayal of the entire foreseeable project over the life of the proposed mine and post-mine closure operations. The project descriptions range from a simplified 20-year mine plan with immediate mine closure and restoration to a 78-year mine plan with much larger pit dimensions. The analysis is silent on the impacts to EFH of larger mine expansion scenarios, although some such scenario seems likely if the initial mine and associated infrastructure are built. Without a complete and accurate description of the entire project scale and scope, including reasonably foreseeable mine expansion, it will not be possible to adequately analyze potential adverse effects to EFH and consider appropriate mitigation measures.

The draft EFH Assessment and DEIS do not clearly identify the geographic extent and impacts of dewatering and re-watering activities that are anticipated for mine construction and operation. Predictions of how far downstream water withdrawals will impact freshwater life stages of salmon remain highly uncertain and not well modeled or predicted for expanded mine scenarios. We would expect the interaction between ground and surface water, upwelling, and lateral inflow to influence salmon spawning site selection and the ability of habitat to support winter egg and larval survival and rearing well beyond the mine footprint. To accurately assess impacts to EFH, the analysis needs to address how far downstream such hydrologic processes are likely to be affected for the initial mine development and future expansion scenarios.

The draft EFH Assessment also does not clearly evaluate expected effects to EFH associated with mine tailings. Although the draft EFH Assessment describes plans to install a lining under the pyritic tailings impoundment to reduce the introduction of acid mine drainage into groundwater, the proposed management methods for water quality, treatment, and discharge are not clear, and thus we cannot determine whether these methods will prevent chronic or catastrophic contaminant release in perpetuity. Exposing porphyry deposits and unwanted and unprocessed ores to oxygen and water inevitably will initiate oxidation-reduction reactions generating some form of mine drainage (alkaline or acidic). The EFH Assessment should fully discuss the magnitude and type of different reactions from three sources: 1) pyritic tailings impoundment; 2) waste rock impoundment; and 3) the eventually water-filled open pit. It should also describe the type of liner to be used and its expected longevity under stressful environmental conditions, such as earthquakes and harsh freeze-thaw cycles, as well as details regarding the design and long-term stability of the proposed earthen tailings impoundment and its ability to contain seepage.

Finally, we urge the Corps and Pebble to revise or further substantiate conclusions in the draft EFH Assessment that portray likely effects to EFH as inconsequential. Section 7.1 on page 120 sums up the effects by saying they "would result in a low degree of impact," "loss of EFH is minimal relative to area that would remain undisturbed," and "habitat removed is generally of low biological importance." The EFH Assessment should objectively describe the loss and degradation of EFH that would occur due to the initial mine project and foreseeable expansion, including potential long-term consequences for water quality and hydrology following mine closure.

MMPA

The MMPA prohibits, with certain exceptions, the "take"[1] of marine mammals in U.S. waters by U.S. citizens. However, the MMPA allows, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity within a specified geographic region. For authorization to take marine mammals incidental to a specified activity other than commercial fishing, a U.S. citizen/entity must apply to NMFS for an incidental take authorization (ITA) under section 101(a)(5)(A or D) of the MMPA. More information on this process can be found at https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act. All incidental take authorizations prescribe the permissible methods of taking and other means of effecting the least practicable adverse impact on a species or stock and its habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance. Issuance of an ITA constitutes a federal action thereby requiring NMFS to make determinations under the National Environmental Policy Act (NEPA) and other applicable environmental laws. Pebble has no active ITA applications in process or authorizations in place; however, NMFS reviewed the DEIS anticipating the need for the final EIS to cover such a request.

Section 3 of the DEIS includes a brief introduction to marine mammal species potentially found within Cook Inlet and Iliamna Lake. NMFS recommends that you add California sea lions (CSL, *Zalophus californianus)* in the final EIS. Although lower Cook Inlet is not historically part of the CSL range, increased sightings of this species in recent years warrant inclusion of this species (Maniscalco *et al*., 2004; Lomac-MacNair *et al*., 2013). The final EIS should also include distinct population segments (DPSs) as some species are incorrectly categorized as non-listed and/or listed under the ESA. The DEIS incorrectly refers to the eastern DPS of Steller sea lions (*Eumetopias jubatus)* as endangered but the eastern DPS was delisted in 2013 (78 FR 66140, November 4, 2013). A similar situation is found with humpback whales (*Megaptera novaeangliae*). While humpback whales are listed as one stock under the MMPA, 14 DPSs have been designated under the ESA (81 FR 62260, September 8, 2016). Both the Mexico DPS

[1] "Take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. "Harassment" is statutorily defined as, any act of pursuit, torment, or annoyance which--

- *(Level A Harassment)* has the potential to injure a marine mammal or marine mammal stock in the wild; or,
- *(Level B Harassment)* has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

(threatened) and the Hawaii DPS (not listed) may occur in lower Cook Inlet. These important distinctions under both the MMPA and ESA should be corrected. While the DEIS identifies species presence, it does not address abundance, density, or seasonality for all of the marine mammal stocks likely to be affected by the project. For example, the DEIS indicates minke whales (*Balaenoptera acutorostrata*) have been observed by NMFS aerial surveys in the action area but does not include an evaluation of how many or how often. These population parameters are critical to evaluating the potential impacts of the project. We also note that the NMFS survey data referenced and used in the DEIS appear to be limited to 2006 for many species, yet more recent data are available. All NMFS survey reports through 2016 are available at https://www.fisheries.noaa.gov/alaska/endangered-species-conservation/research-reports-and-publications-cook-inlet-beluga-whales. Little information beyond presence/absence information from ABR's dedicated research studies is included. NMFS recommends including sighting details such as number of marine mammals observed by species, location, group size, age/sex class, seasonality, behavior, etc. Finally, Chapter 3 provides very broad habitat use descriptions for select species but again is lacking detail. Chapter 3 could be improved by better describing habitat use (e.g., spatio-temporal preferences, foraging, reproduction, haul-outs, etc.) and importance compared to the species' home ranges.

Chapter 4 provides a very high-level overview of potential direct impacts to marine mammals from various components of the project but does not provide the information necessary to determine if those impact are significant under NEPA, nor does it address any indirect effects from the project. For example, the DEIS project area, as described in Table 4.25-1, only includes the area directly associated with marine components of the project and does not consider indirect effects from mine construction and operations, including those habitat and prey concerns described above. For the construction analysis, Chapter 4 in the DEIS limits its marine mammal injury assessment to vessel strikes and does not consider that permanent threshold shift (PTS), which is auditory injury, could occur. It also does not use the best available data to identify marine mammal hearing capabilities (e.g., the Cook Inlet beluga whale section does not cite NMFS (2018), which is necessary to assess the impacts of acoustic exposure on hearing), nor does it include any acoustic modeling or analyses. The DEIS indicates that piles up to 96 inches in diameter could be driven. Driving piles of this size typically results in Level B harassment areas spanning tens of kilometers. Because there is no acoustic analysis, it is unclear how the potential (or lack thereof) for PTS or the potential degree of hearing threshold shifts from the proposed activities was determined. Page 4.25-4 indicates: "*The extent of potential impacts would be within 1.6 to 2.9 miles from the port site, depending on type of hammer used. The method of calculation is detailed in Appendix K4.25.*" However, K4.25 only includes estimated source levels with no calculations or modeling results used to identify the aforementioned distances. We note the DEIS also cites Appendix H (the BA) several times in Chapter 4; however, there is no corresponding information in those documents. This approach of referencing the BA in general for purposes of identifying potential impacts is questionable, since the DEIS should include information in the body of the document for determining the impacts to the human environment under NEPA. Finally, the DEIS does not appear to discuss how effective the proposed mitigation will be at minimizing impacts to marine mammal populations.

Regarding the Spill Risk chapter (4.27), several statements are concerning. For example, page 4.27-23 of the DEIS asserts that any impacts to marine mammals from an oil spill would be temporary, lasting only until the oil has evaporated or broken down, and that marine mammals would be deterred from the area. No references are provided to support these statements in the DEIS, and it is unclear if the Corps believes marine mammals would be deterred from the area on their own accord or if Pebble would take action to deter animals. NOAA and its partners have conducted extensive research on the impacts of oil exposure on marine mammals and it is well documented that health impacts from oil spills can be long lasting and that marine mammals do not actively avoid oil spills (e.g., Loughlin, 1994; Deepwater Trustees, 2016). Actively deterring marine mammals from an oiled area is an extremely complex undertaking and can be unsuccessful. Any plans to undertake such deterrence should be developed in close coordination with NMFS. The DEIS makes similar assumptions should mining products be leaked from vessels and pipelines in that any impacts would be temporary and marine mammals would avoid areas of impact. As with other sources of impacts to marine mammals, this section limits its effects analysis to direct impacts and does not consider impacts to marine mammal prey. A small section (page 4.27-90) discusses impacts to salmon as marine mammal prey but the analysis is unsupported by models or scientific literature. In general, the marine mammal risk assessment from oil and mine products exposure is limited in scope and should be more comprehensive based on the best available science.

Conclusion

In summary, additional information and analysis will be necessary to describe the effects of the Pebble project on ESA-listed species and EFH, and we are highlighting those gaps so the Corps and Pebble can compile the needed information prior to formally requesting that NMFS initiate the required consultations. Similarly, NMFS anticipates that Pebble will seek MMPA incidental take authorization for the project, and we are providing comments to better inform that process. Should you have questions regarding our comments, please contact Greg Balogh regarding ESA issues at greg.balogh@noaa.gov or 907-271-3023; Doug Limpinsel regarding EFH issues at doug.limpinsel@noaa.gov or 907-271-5006; or Jolie Harrison regarding MMPA issues at jolie.harrison@noaa.gov or 301-427-8420.

Sincerely,

for James W. Balsiger, Ph.D.
Administrator, Alaska Region

References

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Study Objectives and Agency Recommendations

Pebble Project
Freshwater, Marine Fish and Instream Flow
Technical Working Groups[1]

Introduction:

Since 2004, State and Federal agency representatives have reviewed study plans and attended annual meetings sponsored by the Pebble Limited Partnership (PLP). Beginning in 2007, agency representatives participated in various Technical Working Groups (TWGs) with PLP to facilitate coordinated agency review, comment, issue clarification and resolution regarding important environmental and project design studies for National Environmental Policy Act (NEPA) and subsequent project permitting actions related to the Pebble Mine Project.

The review of study plans and participation in TWGs has been challenging for agency participants for several reasons. First, the project design itself has not been fully developed by PLP, due to the discovery of additional mineral deposits and further drilling to assess the size of the resource. Currently, there is no definitive project design which would assist agencies in identification of potential project effects. Second, a description of study objectives, rationale, designs, implementation and an assessment of study results remains largely unknown to the agencies. This has hampered agency ability to make recommendations on study plans. Third, quantitative study of the natural environment is an iterative process whereby methods and results are evaluated, theories and hypotheses are refined and technical applications are modified to achieve defined objectives. The PLP has expressed a need for agency representatives to articulate the basis of recommended study objectives with respect to information needed for the various phases of the project including: pre-application studies; preparation of an EIS under NEPA; long-term, post-permitting monitoring, and mitigation.

[1] These guiding principles were jointly prepared by Tim Baker (ADF&G), Phil Brna (USFWS), Jason Dye (ADF&G), Jeff Estensen (ADF&G), Lowell Fair (ADF&G), Dr. Kenneth J. Goldman (ADF&G), Brian Lance (NMFS), Doug Limpinsel (NMFS), Scott Maclean (ADF&G), Doug McBride (USFWS), Jason Mouw (ADF&G), Phil North (EPA), Ted Otis (ADF&G), Cecil Rich (ADF&G), Serena Sweet, (COE), and Dan Young (NPS).

In an effort to address the challenges described above, as well as PLP's need for articulation of the basis for study recommendations, agency representatives[1] have drafted a list of guiding principles which we will use to develop study objectives and recommendations for PLP consideration. The guiding principles represent a consensus among agency participants regarding how we will develop study objectives and recommendations. It is the intent of agency participants that this draft document be provided to PLP and that it be used as the basis for further discussion about study objectives and methods.

Guiding Principles:

1. ***Scientific information is used for permitting and to monitor project effects over time-*** State and Federal agencies recommend that adequate and sufficient information be gathered relative to the proposed Pebble Project and fish populations, fish habitat, and human use of fish in area watersheds including marine waters associated with the port site, to reduce scientific uncertainty related to potential project impacts. This information is required for two primary reasons. First, scientific information will be used in support of project permitting by State and Federal agencies (including development of measures to avoid and minimize project impacts and to compensate for unavoidable impacts). Second, scientific information will be used to monitor and respond to project effects over the life of the project and beyond. This will require development of a monitoring program in which project operators and regulators will need to assure compliance with permit conditions and to assess expected and unexpected project impacts.
2. ***Project permitting includes NEPA-*** Project permitting includes the various State and Federal approvals required to authorize the proposed project, and initially includes the requirements of the National Environmental Policy Act (NEPA) for preparation of an Environmental Impact Statement (EIS). It is in the best interest of PLP and agencies to continue coordination to develop informational needs required to evaluate the proposed project. Recommendations generated by agencies will assist in streamlining the NEPA process prior to submittal of permit applications by PLP. The goal of this early coordination is to reduce delays during the NEPA scoping process by eliminating the need for supplemental data collection after the process begins.

3. ***High quality scientific information is needed for an EIS-*** For an EIS, adequate scientific information is required to describe: the affected environment; range of alternatives, including the environmentally preferred alternative; environmental consequences (a scientific analysis of the direct, indirect, and cumulative environmental effects of the proposed action and of each of the alternatives); the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.
4. ***A cumulative effects analysis needs to apply a high level of scientific rigor-*** Reasonably foreseeable cumulative effects must be addressed during the NEPA process; however, precise requirements are not defined. A cumulative effects analysis must apply the best available science and forecasting techniques to assess potential consequences in the future. Environmental effects are often evaluated from the perspective of the proposed action. Analyzing cumulative effects requires focusing on the resources and ecosystem that may be affected and developing an adequate understanding of how resources are susceptible to effects. Cumulative effects may take many years to develop and may last for many years beyond the life of the action that caused them.
5. ***Agencies have discretion about how much information is needed-*** State and Federal regulations allow considerable discretion on the part of decision makers when making public interest findings about the level of information required for project permitting and environmental analyses. NEPA and the respective State and Federal permit regulations do not specify what constitutes an adequate and sufficient level of scientific information required to make public interest determinations. Agency discretionary authority also applies to determinations regarding adequacy and sufficiency of required scientific information. Considerations for making decisions during the permit process, including the required level of "environmental baseline studies", includes, but is not limited to: the scale and scope of a potential project; the importance and sensitivity of environmental resources and importance to humans; potential risks to the environment, and the threat of litigation.
6. ***Level and extent of information necessary is related to project scale and scope-*** The agency goal in making recommendations for marine and freshwater fish and instream flow studies is to develop a thorough understanding of existing fish populations, habitat characteristics, and

human uses that are potentially at risk from the Pebble Project. Studies should be developed with the appropriate level of scientific precision and accuracy so that rigorous analyses can be made of the direct, indirect and cumulative effects associated with mine development, operation, closure, and post-closure. These studies will allow us to make informed permitting decisions, including requirements to fully mitigate adverse environmental effects resulting from the project, no matter where or when they occur. We consider the quality of the data (precision and accuracy) and the information required from a regulatory perspective to be directly related to the scale, scope, and location of a proposed project. We consider the Pebble project to be large in scale and scope, and it is also located in one of the most biologically productive areas in Alaska. Therefore, the level of information needed for this project from a regulatory perspective is high. In many cases, the quality of needed information for understanding the potential effects of the Pebble Project is of finer resolution than information currently gathered for fisheries management purposes. Information must be of sufficient quality to differentiate potential impacts of the mine from background natural variation.

7. ***Long-term monitoring and reference sites are needed to distinguish between project impacts and natural variability- Fish*** and wildlife populations fluctuate naturally over time as a result of dynamic environmental conditions. In order to distinguish between natural variability and project effects, it is necessary to establish and monitor reference sites outside the influence of impact areas (e.g., Before-After, Control-Impact [BACI] studies). Studies should be able to detect spatial and temporal interaction and include the spatial scale of any potential environmental impact(s). Appropriate reference sites should share similar physical and biological characteristics with impact sites to minimize the number of unshared variables that may influence population variability or trends. Differences in population trends observed between impact and reference sites can then be better attributed to activities at the impact site(s) rather than to natural variability. Without parallel sampling of appropriate reference sites concomitant with monitoring impact sites (before and after project initiation), the ability to recognize and measure project impacts is either greatly diminished or unachievable, making the development of appropriate mitigation strategies to counteract them impossible. A monitoring program should be developed to address both pre- and post-development. The pre-development portion of the program should encompass a sufficient

time period to present a reliable picture of the environment prior to potential project influence. The post-development portion of the program should continue through the project life, reclamation/closure, and far enough into the future to assure that any post-closure impacts are detected and chronicled. As such, the pre-development portion of the monitoring program should be conducted over at least one life cycle of the longest-lived fish species present. Monitoring should continue throughout the duration of the project and following closure to detect long-term direct, indirect, and cumulative impacts so that corrective actions can be taken.

8. ***An understanding of the ecological footprint of the Pebble Project is required***- In making recommendations regarding specific fish and instream flow study objectives, agencies consider the relationship of the full range of potential aspects of the Pebble Project to fish populations, habitat, and human use in a watershed context. We characterize the "full range of potential aspects of the Pebble Project" as including: the immediate mine site; areas downstream of the mine site where effects can be measured; the geographic limits of migratory species that reside in the immediate mine site and areas downstream where effects can be measured; all facilities needed for project construction and operation; the transportation corridor; slurry and fuel pipelines; power generation and supply; the port site; and the shallow water (< 10 fa MLLW) approach corridor required for large vessels to access the port. In formulating our recommendations, we consider the project as planned and designed, but also the possibility or risk that the project will result in unanticipated and unwanted consequences on the environment (e.g., tailings dam failure, grounding of vessels accessing the port or pipeline spills). Biological studies must be broad enough in scope so that we can assess the ecological footprint of the Pebble Project. We recognize that there are likely to be varying degrees of significance associated with various project components (e.g., mine site, transportation corridors, port site, power generation and transmission). The implications of project related risk from an ecological perspective provides the basis for recommendations regarding fish and instream flow studies. We are faced with the challenge of understanding and analyzing complex mine effects over time, within the context of even more complex natural environmental variation.
9. ***Agencies recommend development of SMART objectives***- Specific objectives should be developed for each study with a clearly specified level of precision and accuracy such that

the objectives are statistically sound. With this in mind, agencies recommend that specific study needs and recommendations be based on the SMART objectives concept (**S**pecific- concrete, detailed, well defined; **M**easurable- numbers, quantity, comparison; **A**chievable- feasible, actionable; **R**ealistic- considering resources; and **T**ime-Bound- a defined time line). Attachment A provides "Guidelines for Establishing Project Objectives for Biological Fisheries Investigations."

10. ***Studies should be integrative-*** Fisheries and instream flow studies should be integrative with water quality, quantity, and geomorphology studies to provide a holistic evaluation of habitat use by aquatic organisms and processes that maintain habitat in the project area. Seasonal patterns of habitat use by aquatic organisms are likely related to hydrogeologic and biogeochemical processes. These patterns need to be characterized through the instream flow and water quality studies. Water quality studies including temperature should be three-dimensional and should integrate surface and groundwater studies to understand linkages and resultant patterns in water quality. Fisheries studies should also be integrative with the study of fluvial processes to identify flow regimes that maintain stream channels, floodplain waterbodies, and riparian habitat.
11. ***Agency recommendations are intended to assure sustainability of Bristol Bay and Cook Inlet fish and fisheries-*** Traditional impact analysis tends to focus on how the resource or ecosystem will be modified given a project's development needs. However, the most effective cumulative effects analysis focuses on what is needed to ensure long-term productivity or sustainability of the resource and existing use. This long-term focus has guided our fish and instream flow study recommendations and forms the basis of our responsibility to assure future sustainability of fish and fisheries in the Bristol Bay and Cook Inlet regions.

Agency representatives will provide fish and instream flow study objectives and recommendations to aid impact analysis and permitting decisions for the Pebble project based on these guiding principles. Data and analyses resulting from studies will allow iterative learning about fish populations and the habitats that support them. We believe it is essential that information be shared between PLP and agencies to improve recommendations.

Study Objectives and Recommendations:

Note: Agencies are in discussion regarding the level of accuracy and precision needed to achieve the following objectives. Our goal is to assure that estimated parameters are of sufficient resolution (accuracy and precision) to detect changes in fish abundance and habitat quality in impact and reference reaches over the life of the proposed project and in perpetuity. We have provided draft study objectives which include certain levels of precision and accuracy. However, further analysis is needed to determine if these recommendations will allow us to meet our goal. This analysis may result in revision of these objectives. We hope to undertake this analysis in cooperation with PLP and their consultants in the coming months.

Salmon Studies

Studies are needed to determine the abundance and distribution of adult salmon species in water bodies that could be affected by development of Pebble Mine. Specifically, studies are needed to delineate important spawning reaches and determine the proportion of reaches that will be inundated by the mine or thought to be at risk from mining activities. Study results will be used to assess potential impacts and monitor for changes due to operation of the mine. A c ombination of adult and juvenile studies should be conducted to document the use and productivity of anadromous species in the mine area. It would be preferable to conduct both adult and juvenile studies on all salmon species. However, agencies recognize that it may not be possible to assess both adult and juvenile life stages for all species. Juvenile fish studies should be used to estimate freshwater productivity of anadromous fish species, a component especially important with regard to mining. If juvenile fish studies can not be conducted for a species, agencies recommend that adult fish studies be conducted to estimate the species overall productivity.

Adult Salmon

1) How many adult salmon are in the potentially affected area(s)?

Study Objective / Recommendation: Estimate the abundance of selected adult salmon species in habitats that may be impacted by mine. It is recommended that abundance estimates be

conducted in the South and North Forks of the Koktuli River and Upper Talarik Creek. In addition, abundance estimates should be conducted in at least one ecologically similar reference reach in both the Nushagak and Iliamna drainages that is not associated with the mine; to assess variation not associated with the mine. Abundance estimates should be repeated over a 3-4 year period before and at least a 4-5 year period after initiation of mining activity. Precision of the abundance estimates should be within 10% of the true value 95% of the time (e.g., weirs, visual counting towers, mark-recapture methods) to ensure sufficient statistical power to detect changes in abundance estimates between potentially impacted areas and reference reaches.

Discussion and Justification: Abundance of adult anadromous species should be assessed using methods and techniques that provide the necessary levels of precision and accuracy. Recommended techniques include weirs, visual counting towers, mark-recapture methods and sonar. All of these alternative approaches would provide much higher quality abundance estimates without the inherent problems (unknown stream life, observer efficiency and bias, weather constraints, species identification, etc.) associated with aerial surveys. Agencies do not consider aerial surveys an adequate method for assessing adult fish abundance. Aerial survey methods do not provide the necessary precision and accuracy to assess potential impacts or to monitor for changes due to operation of the mine.

2) How are adult salmon distributed temporally and spatially in habitats (streams and rivers) in the potentially affected area(s)?

Study Objective / Recommendation: Estimate the temporal and spatial use of impact and reference reaches (see above) by adult salmon for migration and spawning. Precision of the estimates should be within 5% of the true value 95% of the time.

Discussion and Justification: Aerial surveys and radio telemetry can be combined to accurately determine the majority of spawning areas within a reach. Numbers of radio tags should be sufficient to estimate proportional use of a predetermined number of reaches such that the desired precision (5%) and accuracy (95%) can be attained. This objective should be completed for all salmon species (Chinook, coho, chum, pink and sockeye) in all of the potentially affected habitats and reference reaches.

3) What are the habitat characteristics important to adult spawning salmon in potentially affected areas?

Study Objective / Recommendation: Measure critical habitat characteristics (e.g., channel type, flow, bottom sediment, and groundwater) at reaches used for spawning and compare these characteristics with those in adjacent reaches that do not contain spawning adults.

Discussion and Justification: The hypothesis to be tested is that habitat characteristics in reaches used for spawning do not differ from reaches not used for spawning. The theoretical basis of this test is to determine if spawning in study reaches is limited by available habitat . This objective should be completed for all salmon species (Chinook, coho, chum, pink and sockeye) that are present in the study areas.

4) Maximize documentation of the distribution of anadromous fish in the Anadromous Waters Catalog (AWC) throughout the ecological footprint of the mine.

Study Objective / Recommendation: Inventories are needed to document water bodies utilized by anadromous fish species in the area potentially impacted by mine activities. This study will conduct inventories for anadromous fish species using a range of collection methods (mark-recapture including PIT tagging, electrofishing, minnow trapping, snorkeling). Surveys should be conducted in the full range of habitats used by each species (e.g., mainstem, side channel, headwater tributary, spring/groundwater fed reaches, beaver ponds, and lakes) and at sites where fish are not found in initial surveys, surveys should be repeated in at least one subsequent year. Rearing coho salmon are thought to be maximally distributed in headwater streams during the month of August and thus surveys to document rearing habitats should be conducted during this period. For facultative anadromous species such as Dolly Varden, humpback whitefish, and least cisco, microchemical analysis should be conducted to detect evidence of migration to saltwater in adults (for all three species) and juvenile (Dolly Varden maternal anadromy). Note: Humpback whitefish and least cisco have been reported from lakes in the Koktuli River drainage (Buell 1991), but otolith microchemistry (and/or tracking of adult movements) studies are needed to determine whether anadromy occurs in these populations.

Discussion and Justification: To be protected under AS 16.05.871, water bodies must be documented as supporting some life function of an anadromous fish species (salmon, trout, char, whitefish, sturgeon, etc.).

5) What is the contribution of salmon from potentially affected areas to area fisheries?

Study Objective / Recommendation: Estimate the contribution of salmon from potentially affected areas to the area commercial, sport, and subsistence fisheries. Estimates should be within 10% of the true value 95% of the time.

Discussion and Justification: Existing fisheries uses could be affected by lost production from the mine. Little if any fisheries use occurs within the mine site; however, salmon from the potentially affected areas could significantly contribute to area fisheries.

Juvenile Salmon

Juvenile salmon studies are needed to determine freshwater production in study reaches (both potentially impacted and reference). Study results will be used to assess potential impacts and monitor for changes due to operation of the mine.

1) Of what importance are potentially affected area(s) to rearing juvenile salmon?

Study Objective / Recommendation: Determine the location and migratory patterns of juvenile salmon in areas that could be potentially impacted by the mine. Migratory patterns, particularly for Chinook and coho salmon, could be complex and will require seasonal assessment by life stage. Precision of the distribution estimates should be within 10% of the true value 95% of the time. This objective should be completed for all juvenile salmon species (Chinook, coho, chum, pink and sockeye) in the study areas.

Discussion and Justification: This will likely require capture and tagging of juvenile salmon. Likely capture methods include minnow traps, incline plane traps, weirs, and rotary screw traps. Juveniles that rear in potentially affected areas may have originated elsewhere, and *visa versa*.

2) How many juvenile salmon are produced in the potentially affected area(s)?

Study Objective / Recommendation: Estimate abundance of selected juvenile salmon species as emigrating smolt and/or fry in one or more study reaches associated with the mine (including the mine site(s) and any transportation corridors) and in one or more reference reaches not associated with the mine, but in a similar drainage (see example above). Estimate the contribution of the potentially affected areas to the juvenile production from the Nushagak and Iliamna river drainages. Assessments should be repeated over a 3-4 year period before and at least a 4-5 year period after initiation of mining activity. Precision should be within 10% of the true value 95% of the time (e.g., mark-recapture, weir) to ensure sufficient statistical power to detect changes in abundance trends between impact and reference reaches.

Discussion and Justification: This objective should be completed for salmon species where it is easiest to assess freshwater stages. Chinook and coho salmon are the highest priority but studies should be initiated to estimate the production of sockeye salmon fry from the study areas. Methods combining mark-recapture methods with incline-plane or rotary screw traps have been successful in providing estimates of salmon fry/smolts in streams in other areas.

3) What are the habitat characteristics important to juvenile salmon in potentially affected area(s)?

Study Objective / Recommendation: Measure critical habitat characteristics at reaches used for different stages of rearing and compare these characteristics with those in adjacent reaches that do not contain rearing juveniles.

Discussion and Justification: Understanding the full range of habitats used by rearing salmon and the productivity of these habitats is needed to detect and evaluate effects of development. The hypothesis to be tested is that habitat characteristics in reaches used for rearing do not differ from reaches not used for rearing. The theoretical basis of this test is to determine if rearing in study reaches is limited by available habitat. This objective should be completed for all salmon species (Chinook, coho, chum, pink and sockeye) that are present in the study areas.

Adult Non-Salmon Species[2]

Adult non-salmon studies are needed to determine freshwater presence/absence, abundance, and life history in study reaches (both impact and reference). Study results will be used to assess potential impacts and monitor for changes due to operation of the mine.

1) What are the major non-salmon fish species that utilize the potentially affected areas?

Study Objective / Recommendation: Estimate the seasonal distribution of resident and non-salmon anadromous fish species within the potentially affected areas of adult rainbow trout, Arctic grayling, northern pike, Dolly Varden, and whitefish <spp> in the Upper Talarik and Koktuli (north fork, south fork, and mainstem) drainages annually for a period of at least 3 years such that estimates of proportional use by selected reaches is within 5% of the true value 95% of the time.

Discussion and Justification: Documentation of seasonal distribution of non-salmon fish species within the potential affected areas is unknown. Life history patterns of many resident and non-salmon anadromous species is complicated and could involve migrations to spawning, and feeding sites.

2) What is the abundance, distribution and migratory patterns for major non-salmon species that utilize the potentially affected areas?

Study Objective / Recommendation: Determine the migratory patterns of major non-salmon species that utilize the potentially affected areas throughout the Nushagak and Iliamna drainages. Determine spawning locations and populations and estimate the abundance and contribution from potentially affected areas to those spawning populations. This work should be conducted for rainbow trout and other major species that utilize the potentially affected areas. Estimates should be conducted annually for a period of at least 3 years prior to initiation of mining activity and every 4 years following initiation of mining activity such that the estimate is within 15% of the true abundance 95% of the time.

[2] The non-salmon species category includes resident species (e.g. rainbow trout, whitefish, Arctic grayling, northern pike) and non-salmon anadromous species (e.g. Dolly Varden, cisco, smelt)

Discussion and Justification: Abundance of spawning resident and non-salmon anadromous fish species (rainbow trout, Arctic grayling, northern pike, and Dolly Varden) is unknown in both the Upper Talarik and Koktuli drainages.

3) What habitat characteristics are important to the major non-salmon fish in the potentially affected areas?

Study Objective / Recommendation: Describe and measure spawning, feeding, and overwintering habitat characteristics for the major resident and non-salmon anadromous fish species that utilize the potentially affected areas. Sampling should be conducted in the potentially affected areas annually for a period of at least 3 years prior to initiation of mining activity.

Discussion and Justification: Resident and non-salmon anadromous fish species spawning and overwintering habitat characteristics have not been fully described in the Upper Talarik and Koktuli drainages. The hypothesis to be tested is that habitat characteristics in reaches used for spawning, overwintering, or feeding do not differ from reaches not used for these functions. The theoretical basis of this test is to determine if utilization of study reaches in the potentially affected areas is limited by available habitat. This objective should be completed for all major non-salmon species that are present in the study areas.

4) What is the contribution of rainbow trout and other major non-salmon species from potentially affected areas to area fisheries?

Study Objective / Recommendation: Estimate the contribution of major non-salmon species from potentially affected areas to the area sport and subsistence fisheries. Estimates should be within 10% of the true value 95% of the time.

Discussion and Justification: Existing fisheries could be affected with reductions in fish production related to the mine. Little if any fisheries use occurs within the mine site; however, salmon from the potentially affected areas could significantly contribute to area fisheries.

Juvenile Non-Salmon Species

Juvenile non-salmon studies are needed to determine freshwater presence/absence, abundance, and life history in study reaches (both impact and reference). Study results will be used to assess potential impacts and monitor for changes due to operation of the mine.

1) Of what importance are potentially affected area(s) to juvenile resident and non-salmon anadromous species?

Study Objective / Recommendation: Document the presence/absence of juvenile rainbow trout, Arctic grayling, northern pike, Dolly Varden, and whitefish <spp> in the Upper Talarik and Koktuli (north fork, south fork, and mainstem) drainages annually for a period of at least 3 years. Determine the location and migratory patterns for the major species of juvenile non-salmon in areas that could be potentially impacted by the mine. Migratory patterns for these species could be complex and will require seasonal assessment by life stage. Precision of the distribution estimates should be within 10% of the true value 95% of the time.

Discussion and Justification: Presence/absence of juvenile resident species is undocumented/unknown in much of the Upper Talarik and Koktuli drainages. This will likely require capture and tagging of juvenile fish. Likely capture methods include minnow traps, incline plane traps, weirs, and rotary screw traps. Juveniles that rear in potentially affected areas may have originated elsewhere, and *visa versa*.

2) What are the habitat characteristics important to rearing non-salmon juveniles in the potentially affected areas?

Study Objective / Recommendation: Describe rearing habitat characteristics for juvenile non-salmon species. Measure critical habitat characteristics at reaches used for different stages of rearing and compare these characteristics with those in adjacent reaches that do not contain rearing juveniles. Sampling should be conducted annually for a period of at least 3 years.

Discussion and Justification: Juvenile rearing habitat characteristics have not been fully described in the Upper Talarik and Koktuli drainages. Understanding the full range of habitats

used by rearing juveniles and the productivity of these habitats is needed to detect and evaluate effects of development. The hypothesis to be tested is that habitat characteristics in reaches used for rearing do not differ from reaches not used for rearing. The theoretical basis of this test is to determine if rearing in study reaches is limited by available habitat. This objective should be completed for all major non-salmon species that are present in the potentially affected areas.

MARINE FISH

For organizational purposes, the Marine Fish section is divided into three subsections: 1) General Marine Studies, 2) Marine Finfish, and 3) Shellfish and Groundfish. Unlike the freshwater fish section, marine fish studies were not stratified by juvenile and adult life stages.

General Marine Studies (GMS)

Studies are needed to determine the oceanographic conditions (water movement direction and velocity) in the vicinity of the port facility and the shallow water (<10 fa) approach corridor required for large vessels to access the port, as well as throughout the greater Kamishak Bay area. These are critical to determine the potential trajectory or trajectories of contaminants such as fuel and lubricants that will leak into the environment from ships using the approach corridor and port facility, as well as from any potential accidents or incidents that occur at or near the port facility, such as port holding tank spills and vessel groundings. Collection of environmental data such as temperature, salinity and oxygen levels should be conducted simultaneously to this work and all assessment work suggested herein. In addition, we strongly suggest that baseline levels of contaminants in the sediment and in a wide range of marine organisms be determined. Finally, high resolution bottom mapping (bathymetry and bottom type) is needed throughout Iniskin and Cottonwood/Illiamna bays, along the vessel approach corridor, and in potential reference bays (e.g., Bruin, Chinitna, and outer Akumwarvik bays and McNeil Cove). The sea floor maps will be used to quantify impacted habitats, select appropriate replicate and reference sites to address specific objectives outlined below, and to facilitate habitat-based abundance surveys of species occupying select habitats.

1) What are the oceanographic conditions that would elucidate probable spill trajectories in the potentially affected area(s)?

Study Objective / Recommendation: Provide detailed results on oceanographic conditions from Chinitna Bay (just north of the port facility area) south to Cape Douglas including the entire Kamishak Bay area. These results need to include data on water movement direction and velocity from the surface to the bottom, and environmental conditions such as temperature, salinity and oxygen levels at various depths throughout the water column. We strongly urge PLP and their consultants to integrate their work and results with the Alaska Ocean Observing System (AOOS) to improve current observations and models of water flow in lower Cook Inlet.

Discussion and Justification: It is critical to understand the potential trajectory or trajectories of contaminants (e.g. fuel and lubricants) that will spill into the environment from ships using the approach corridor and port facility as well as from any potential accidents or incidents that occur at or near the port facility (e.g. port holding tank spills and vessel groundings). In the case of a major accident or incident, spill recovery teams must know the appropriate places to stage their crews - knowing the spill trajectory that any spill type (e.g. fuel vs. lubricants) may take and where contaminants may wind up is imperative to minimizing environmental damage.

2) What are the baseline contaminant levels of sediments in the potentially affected area(s)?

Study Objective / Recommendation: Document baseline contaminant levels (e.g. heavy metals, PCB's and PAH's) in the sediment at impact and reference sites. We suggest randomly selecting a sufficient number of stations to sample throughout the Kamishak Bay area, and suggest the following three reference sites be included: Chinitna Bay, Bruin Bay and either outer McNeil Cove or outer Akumwarvik Bay.

Discussion and Justification: It is critical to establish baseline data documenting the presence and current levels of contaminants in the marine environment at, and in areas adjacent to, the vessel approach corridor and port location. These data must be sensitive enough to evaluate the effects of contaminants in marine organisms and their potential to impact human health.

3) What are the baseline contaminant levels in marine organisms occupying the potentially affected area(s)?

Study Objective / Recommendation: Document baseline contaminant levels (e.g. heavy metals, PCB's and PAH's) in a wide range of marine organisms captured during surveys. Organisms sampled should include, but not be exclusive to, Pacific salmon, Pacific herring, Tanner, red king and Dungeness crab, weathervane scallops, flatfishes (e.g. flathead, Dover, and yellowfin sole), rockfishes (e.g. rougheye and dusky), Pacific cod, pollock, sand lance, and eulachon. Hard shell clams (e.g. razor and butter) and mussels should also be sampled.

Discussion and Justification: It is critical to establish baseline data documenting the presence and current levels of contaminants in marine organisms at, and in areas adjacent to, the vessel approach corridor and port location. Toxic responses can occur at the cellular, organism, population and community levels and range from metabolic impairment to changes in community structure and function. The toxic responses are not limited to the initial organism, but may extend throughout the food web including humans via seafood consumption. Compounds such as PCB's are well known to bioaccumulate in animal tissue, biomagnify through the food web and have been shown to elicit adverse effects at relatively low concentrations. As such, these data must be sensitive enough to evaluate the effects of contaminants in marine organisms and their potential to impact human health.

4) What impact will dredging have on marine habitat and organisms in the potentially affected area(s)?

Study Objective / Recommendation: Estimate the volume of sediment that will be removed if dredging is necessary for the vessel approach corridor to the Mine's port facility, or for the port itself. Estimate the number of Tanner, Dungeness and red king crab, and scallops that are killed during dredging activities.

Another question regarding dredging is where will the dredge spoils be dumped? If dredge spoils are to be dumped in the marine environment, a high mortality may be induced on groundfish and shellfish in that location and areas immediately adjacent to it.

Discussion and Justification: It is important to know how much area will be directly impacted by dredging activities. Dredging will likely cause direct mortality of benthic organisms within the dredge path and beneath materials deposited off to the side of the path, both of which should be estimated.

If spoils are to be dumped in the marine environment, that presents another area that needs to have baseline data collected and that needs to be monitored over time.

5) How will suspended sediments caused by dredging affect marine habitat and organisms in the potentially affected area(s)?

Study Objective / Recommendation: Test sediment for size construct and estimate the amount of sediment that will become suspended in the water column if dredging is necessary for the vessel approach corridor to the Mine's port facility. Estimate the amounts and locations where the sediment will relocate to. This can be done in concert with oceanographic information that was previously requested.

The above is also relevant and important if there is to be dredging in future years to keep the vessel corridor to the Mine's port facility open and operational. If future dredging will be necessary to keep the vessel corridor open then the suggested studies should be repeated prior to that dredging.

Discussion and Justification: It is critical to know how much suspended material there will be from dredging and the potential trajectory or trajectories of that suspended material. Different size material in suspension will settle at different rates depending on current flow intensity and in different locations based on overall water movement in the area. Understanding the sediment sizes is critical to estimating where suspended sediment will settle to the bottom. While this is a concern for all species that live on or in the benthos that could be killed by settling sediment, the major species of concern are Tanner crab and weathervane scallops as there are active fisheries for both species in Kamishak Bay. Any path that vessels will take to the Mine's port facility is immediately adjacent to commercially fished scallop beds and to areas the public fishes for Tanner crab. Additionally, an ADF&G survey shows Tanner crab numbers have been increasing

in recent years and the stock may be building back towards commercial fishing levels – this could be stifled by effects of sedimentation killing Tanner crab and/or altering the benthic environment. Both species mentioned above (as well as numerous others) could be impacted via direct means as stated above and via indirect means from adverse effects on their prey base from sedimentation.

6) What marine habitat types occur in the potentially affected area(s)?

Study Objective / Recommendation: Measure the physical/chemical/biological habitat characteristics (e.g., depth/elevation relative to MLLW; substrate composition; slope; salinity; benthic algal/faunal species composition, diversity, and density [e.g., stems/m^2]; bottom complexity/rugosity; etc.) at all marine sites potentially impacted by port construction and operation (e.g., fill areas, pilings, dredge path, dredge spoil dumping areas) and throughout the greater Iniskin and Cottonwood/Illiamna bay areas. Quantify the absolute areas and relative proportions of distinct habitat types. Recommended methods include a combination of high resolution bottom mapping using sonar and/or bathymetric LIDAR in combination with using SCUBA divers to sample substrate composition and benthic community structure along transects established inside and outside areas potentially impacted by construction/operation of the port and vessel approach corridor.

Discussion and Justification: This objective is necessary to: a) quantify habitat types destroyed or modified during port construction, b) facilitate selection of appropriate reference sites in bays not impacted by the port (see GMS Objective 7), and c) facilitate habitat-based assessments of select species. In addition to documenting physical habitats, it is important to quantify biological habitat. Canopy and understory forming kelp and algae provide structurally complex habitats essential to select life stages of a variety of marine organisms. It's critical to determine if habitat(s) impacted by construction/operation of the port facility represent unique or uncommon habitats, which may have a disproportionately greater importance to marine fish using the area during select seasons or life stages. Results will facilitate design of appropriate mitigation activities required to offset loss of habitat caused by port construction. Results will also facilitate selection of appropriate reference sites in non-impact bays for comparison with

impact sites in Iniskin and Cottonwood/Illiamna bays. Finally, results should be used to develop habitat-based species assessments.

7) What marine habitat types occur in areas potentially used as reference sites?

Study Objective / Recommendation: Measure the physical/chemical/biological habitat characteristics throughout potential reference bays (e.g., Bruin, Chinitna and outer Akumwarvik bays and McNeil Cove). Quantify the absolute areas and relative proportions of distinct habitat types (including vegetated habitats). Recommended methods include a combination of high resolution bottom mapping using sonar and/or bathymetric LIDAR in combination with using SCUBA divers to sample substrate composition and benthic community structure along transects established throughout reference bays.

Discussion and Justification: This objective is necessary to: a) facilitate selection of appropriate reference sites in bays not impacted by the port (see GMS Objective 6), and b) facilitate habitat-based assessments of select species in those areas. Results will facilitate selection of appropriate reference sites in non-impact bays for comparison with impact sites. Results should also be used to develop habitat-based species assessments.

8) What species and life stages use the unique deepwater habitat at Knoll Head?

Study Objective / Recommendation: Describe and, to the extent possible, quantify the seasonal use of the 12 fa hole at Knoll Head at the mouth of Iniskin Bay (impact site) and the 11-12 fa channel at the northeast entrance to Chinitna Bay (reference site) by juvenile and adult marine finfish, shellfish and groundfish. Surveys at both sites should be repeated at high, mid (flood and ebb), and low tide monthly to characterize tide and season induced variability in species composition and abundance. Assessment should occur over at least a 3 year period before project initiation with subsequent two to three year study periods every 10 years throughout the duration of port operation to monitor for long-term accumulative impacts. Test the hypothesis that intra- and inter-annual seasonal use trends between impact and reference sites are similar. Recommended techniques include hydroacoustic surveys (incorporating echo-integration to

estimate biomass) and concurrent capture efforts (e.g., small mesh purse-seining and/or mid-water and bottom trawling) to determine the species composition of sonar targets.

Discussion and Justification: Assessment methods currently used by PLP consultants do not adequately sample deep water habitats in the immediate vicinity of the proposed deep-water port site. The 12 fa hole at Knoll Head at the mouth of Iniskin Bay represents the only near-shore deep-water (10+ fa) habitat in all of Kamishak Bay. As such, it may be an important staging, feeding, spawning, and/or overwintering area for species that wouldn't otherwise inhabit the area. Construction and year round operation of a major port at Knoll Head could change how this unique habitat is used by marine fish (and their predators). Baseline characterization of this site's seasonal use by marine fish prior to project initiation is necessary to monitor for changes during port construction and operation.

9) What species and life stages use all the different marine habitats available within the potentially affected area(s)?

Study Objective / Recommendation: Describe, and to the extent possible, quantify the seasonal abundance and distribution of larval, juvenile, and adult marine fish using habitats identified by GMS Objectives 6 and 7 within impact and reference sites. All habitat types represented in impact and reference areas should be sampled using methods appropriate to each habitat (e.g., small-mesh beach seines for fine sediment, low gradient, beaches; video sled, ROV or SCUBA for rocky inter- and subtidal habitats, 400 Eastern mid/bottom trawl for mid-water and smooth bottom subtidal habitats, etc.). Surveys should be repeated using standardized effort and methods at various tide stages monthly to characterize tide and season induced variability in species composition and abundance. Assessment should occur over at least a 3 year period before project initiation with subsequent 2-3 year study periods every 10 years throughout the duration of port operation to monitor for long-term accumulative impacts. Along with those already mentioned, recommended techniques include hydroacoustic surveys incorporating echo-integration of targets to estimate biomass and concurrent capture efforts (e.g., small mesh seining and/or mid-water and bottom trawling) to determine species composition.

Discussion and Justification: To be effective, baseline marine fish studies must sample all representative habitats that are available in impact and reference areas. Areas potentially impacted by port construction/operation include the approach corridor that deep draft (>5 fa) vessels will use to transit shallow (< 10 fa) water to access the port. Sampling of each habitat type must employ easily repeatable, standardized methods and effort so relative abundance trends can be compared across sampling events and sample years. It is recommended that sampling effort within representative habitats be conducted commensurate to each habitat's availability.

10) What are the catchability coefficients for key target species and life stages relative to the fishing gears used to survey the potential affected area(s)?

Study Objective / Recommendation: Estimate the catchability coefficients for key target species and life stages (e.g., juvenile and adult salmon, herring, shrimp, crab, and flatfish) relative to the habitats sampled and gear types used to address GMS Objectives 8 and 9. This objective can be addressed with a one year study in conjunction with the study addressing GMS Objectives 8 and 9.

Discussion and Justification: To remove some of the sampling error that leads to catches of some species being highly variable and not representative of true abundance, PLP should quantify the bias each gear type (used to address GMS Objectives 8 and 9) has relative to select species and habitat types sampled (e.g., use underwater video in conjunction with bottom trawling to determine the catchability coefficients for crab, skates, and flatfish, all of which have a tendency to escape under the foot rope).

Marine Finfish (MF)

Studies are needed to determine the seasonal abundance and distribution of larval, juvenile, and adult marine finfish (e.g., salmon, herring, sand lance, eulachon, smelt, etc.) in estuarine and marine environments that could be affected by mine related facilities. Specifically, studies are needed to identify important spawning, rearing, feeding, and over-wintering areas that might be negatively impacted by the construction and operation of the slurry pipeline/transportation

corridor, the port facility, and the shallow water approach corridor large vessels will use to access the port. Simultaneous collection of similar baseline data at nearby reference sites should be done prior to and after port construction to account for natural variability when future monitoring efforts are conducted to assess potential impacts (e.g., loss of productivity) associated with construction and operation of the port facility.

1) What is the temporal and spatial extent of Pacific herring spawning activity within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Quantify the temporal (timing and number of days of active spawn) and spatial (kilometers of shoreline receiving spawn) extent of Pacific herring spawning events in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port facility (e.g., Bruin and Chinitna bays). Assessments should be repeated over at least a six consecutive year period before project initiation with subsequent six consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts. The temporal and spatial resolution of methods used to document spawning events should be sufficient to detect intra- and inter- annual differences in the number of spawning events and the timing, duration, and distribution of spawning events within and between impact and reference areas.

Discussion and Justification: Quantifying the temporal and spatial extent of spawning events in impact and reference areas is necessary to detect potential impacts associated with the construction and operation of the port facility and to facilitate MF Objective 2, below. Six consecutive year study periods will cover the average mature life span of one generation of Kamishak Bay herring (age-3 to 9) and increase the likelihood of capturing a strong recruitment event. Recommended methods to obtain the required temporal/spatial precision include frequent aerial surveys where observers document the date, precise location, and linear kilometers of spawn associated with all spawning events occurring in impact and reference areas.

2) How many herring spawn within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the number of Pacific herring that spawn in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays) through egg deposition surveys. Precision of total spawner estimates should be within 25% of the true value 95% of the time to ensure sufficient statistical power to detect changes in spawner abundance trends between impact and reference areas and within impact areas over time. Annual estimates should be repeated over at least a six consecutive year period before project initiation with subsequent six consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts. To back-calculate spawning biomass from egg deposition surveys, sub-objectives 2a through 2d below must first be met.

Discussion and Justification: Data obtained from sub-objectives 2a-2d (e.g., total eggs deposited, egg loss, age, sex, size composition, and fecundity and natural egg retention at age/size of the spawning population) will provide the parameter estimates necessary to calculate the total number of herring that spawned in impact and reference areas annually.

2a) How many herring eggs are deposited annually within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the total number of eggs deposited by Pacific herring in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays). Annual estimates should be repeated over at least a six consecutive year period before project initiation with subsequent six consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts. Target sampling intensities should be sufficient to achieve mean egg density estimates with standard errors no greater than 25% to ensure sufficient statistical power to detect changes in spawning magnitude trends between impact and reference areas over time.

Discussion and Justification: Abundance of eggs should be assessed using a method that assures the specified levels of accuracy and precision. Recommended methods include diver-

based egg deposition surveys of inter- and subtidal areas receiving spawn, as determined by MF Objective 1, above). Six year study periods are recommended to increase the likelihood of capturing periodic strong recruitment events and to facilitate Objective 2. Along with facilitating estimates of spawner abundance (see MF Objective 2), precise spawn deposition data will provide a key input for evaluating early marine survival (see MF Objective 3).

2b) What is the age, sex, and size composition of Pacific herring spawning within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the age, sex, and size (length and weight) composition of Pacific herring that spawn in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays). Annual estimates should be repeated over at least a six consecutive year period before project initiation with subsequent six consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts. The timing of this study should coincide with sub-objective 2c so Objectives 2 and 3 can be addressed. Precision of estimates should be within 5% of the true age composition 90% of the time to ensure sufficient statistical power to detect changes in age composition between impact and reference areas over time.

Discussion and Justification: To assure sampling represents the true age, sex, and size composition of spawning aggregates using impact and reference areas, samples should be collected from each spawning "wave" with unbiased sampling gear such as purse seines or cast nets. Based on previous agency experience and multinomial sampling theory, sample sizes of at least 480 fish are required from each spawning wave to meet the specified precision level. Individual samples should be weighted by the relative abundance of the spawning biomass they represent before estimating the annual age, sex, and size composition of the spawning population.

2c) What is the fecundity and natural egg retention at age for Pacific herring spawning within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the fecundity and natural egg retention at age/size for Pacific herring that spawn in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays). Annual estimates should be repeated over at least a six consecutive year period before project initiation with subsequent six consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts. The timing of this study should coincide with MF sub-objectives 2b above, so that MF Objective 2 can be addressed. Precision of fecundity and egg retention at age/size estimates should be within 10% of the true value 95% of the time to ensure sufficient statistical power to detect changes in fecundity and egg retention rates between impact and reference areas over time.

Discussion and Justification: Samples collected to address Objective 2b may also be used to address this objective. However, samples must be stratified by spawning status (pre- and post-spawning) with enough samples within each group to assure appropriate precision for estimates of fecundity and egg retention.

2d) How many herring eggs are removed by predators between the time of spawning and dive surveys to estimate egg deposition within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate egg loss between the time of egg deposition and dive surveys (see MF sub-objective 2a) for Pacific herring that spawn in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays) such that the estimate is within 10% of the actual egg loss 95% of the time. Because inter-annual variability in egg loss correction factors can be large, egg loss estimates should be made each year spawn deposition surveys are conducted to estimate egg deposition (see MF Objective 2a) and total spawning biomass (see MF Objective 2).

Discussion and Justification: Herring egg loss due to fish and avian predators can sometimes approach 100% of all eggs deposited. Therefore, estimates of egg loss between the time of spawning and dive surveys are necessary to estimate spawning biomass from egg deposition

surveys (see MF Objective 2). Recommended approaches include egg loss models that incorporate vegetation type, wave exposure, abundance of avian predators, and cumulative time of exposure to air during incubation.

3) What is the early marine survival of Pacific herring spawning and rearing within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Test the hypothesis that early marine survival of Pacific herring in impact areas (e.g., Iniskin and Cottonwood/Illiamna bays) is the same as that in reference areas (e.g., Bruin and Chinitna bays), such to detect at least a difference of 0.25 between survival rates with the probability of Type I and II errors set at 0.05 and 0.10, respectively. This objective cannot be addressed until year 4 of the studies developed to address MF Objective 2, above. To obtain three years of marine-survival-through-recruitment data, it is recommended that the studies addressing MF Objective 2 be repeated annually for six consecutive years prior to project initiation with subsequent 6-consecutive year study periods each decade for the first 20 years of port facility operation, and six consecutive year study periods every 20 years thereafter to monitor for long-term accumulative impacts.

Discussion and Justification: Data obtained from MF Objective 2 will provide the necessary data with which to test this hypothesis during the final three years of each six year study period outlined in MF Objective 2, above. The duration of iterative study periods could be shortened by developing methods to estimate the abundance of age-1 through age-3 juvenile fish in impact and reference areas with adequate precision. However, given the difficulty of that task, the recommended approach is likely the most feasible for evaluating the impact port construction/operation may have on juvenile herring marine survival and overall herring productivity

4) What are the infection rates for viral hemorrhagic septicemia virus (VHSV) and *Ichthyophonus spp.* in juvenile and adult Pacific herring within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the infection rates for viral hemorrhagic septicemia virus (VHSV) and *Ichthyophonus spp.* in juvenile and adult Pacific herring in Iniskin and Cottonwood/Illiamna bays (impact areas) and in one or more reference areas not associated with the port (e.g., Bruin and Chinitna bays). Annual estimates should be repeated over at least a four year period before project initiation with subsequent two year study periods every 10 years throughout the duration of port facility operation to monitor for long-term, accumulative impacts. Precision should be within 10% of the true value 95% of the time to ensure sufficient statistical power to detect changes in infection rates between impact and reference areas over time.

Discussion and Justification: VHSV and *Ichthyophonus spp.* can cause increased mortality rates in young and old herring, respectively, and have been implicated as key factors in population level declines of Pacific herring. Because stressor events are sometimes implicated as catalysts for epizootic outbreaks, PLP should develop a disease assessment program to monitor trends in the rates of infection at impact and reference sites before and after project initiation. Samples obtained to address MF Objectives 2b and 2c can also be used for disease assessment.

5) Is spawning by Pacific herring in the potentially affected area(s) limited by a lack of appropriate spawning habitat?

Study Objective / Recommendation: Measure the physical/chemical/biological habitat characteristics (e.g., depth/elevation relative to MLLW; substrate composition; slope; salinity; benthic algal/faunal species composition, diversity, and density [e.g., stems/m^2]; bottom complexity/rugosity; etc.) at sites used for spawning by Pacific herring (see MF Objective 1) and compare these characteristics with those at sites not used for spawning in impact and reference areas (see GMS Objectives 6 and 7). The hypothesis to be tested is that habitat characteristics at sites used for spawning do not differ from sites not used for spawning. The theoretical basis of this test is to determine if current spawning activity in Iniskin and Cottonwood/Illiamna bays is limited by available habitat or not. This objective can be met with a one year study concurrent with MF Objective 2a. Recommended methods include a combination of high resolution bottom mapping using sonar and/or LIDAR in combination with using SCUBA divers to sample substrate composition and benthic community structure along transects established inside and outside areas used for spawning.

Discussion and Justification: Current agency surveys indicate Pacific herring are not as abundant in Kamishak Bay as they were in past decades. Baseline spawning surveys that are conducted during low abundance periods are unlikely to be representative of the broad range of sites used during periods of high abundance. This objective is necessary to evaluate whether the spawning activity and distribution observed in the port facility area prior to port construction/operation was limited by available spawning habitat.

6) What is the marine survival of pink and chum salmon emigrating from streams within and adjacent to areas potentially affected by construction and operation of the port facility and transportation corridor along the coast?

Study Objective / Recommendation: Test the hypothesis that marine survival of pink and chum salmon from impact streams (Iniskin River, Knoll's Head Creek [aka Y-Valley Creek], and Cottonwood Creek) is similar to that of one or more reference streams (e.g., Bruin River, Ursus/Rocky coves), such as to detect at least a difference of 0.20 between survival rates with the probability of Type I and II errors set at 0.05 and 0.10, respectively. Assessment should occur over at least a seven consecutive year period before project initiation with subsequent seven consecutive year study periods every 20 years throughout the duration of port operation to monitor for long-term accumulative impacts. Seven-year study periods will facilitate marine survival estimates for at least one brood year of chum salmon and five brood years of pink salmon. To estimate marine survival of pink and chum salmon fry emigrating from streams in potentially affected areas, sub-objectives 6a and 6b must first be met.

Discussion and Justification: Recently emigrated pink and chum salmon fry often reside in estuaries and embayments near their natal streams for several weeks to months. Natural mortality associated with this critical period of their early life history is often one of the key determinants of brood year success, and is therefore a major factor affecting the overall productivity of the stock. Construction and operation of a large port facility may directly (loss of habitat, contamination) or indirectly (loss of prey) lead to lower marine survival rates, therefore lowering pink and chum salmon productivity. This study provides a means for estimating rates

of marine survival at impact and reference sites. Results will be used to quantify potential impacts and develop mitigations strategies, if necessary.

6a) How many pink and chum salmon fry emigrate from streams within and adjacent to areas potentially affected by construction and operation of the port facility and transportation corridor along the coast?

Study Objective / Recommendation: Estimate the abundance of juvenile pink and chum salmon fry emigrating from impact streams (Iniskin River, Knoll's Head Creek [aka Y-Valley Creek], and Cottonwood Creek) nearby the port facility (including the transportation corridor), and in one or more reference streams (e.g., Bruin River, Ursus/Rocky coves) in Kamishak Bay. Assessment should occur over at least a seven consecutive year period before project initiation with subsequent seven consecutive year study periods every 20 years throughout the duration of port operation to monitor for long-term accumulative impacts. Precision should be within 10% of the true value 95% of the time to ensure sufficient statistical power to detect changes in abundance trends between impact and reference streams.

Discussion and Justification: Abundance of juvenile anadromous species should be assessed using methods and techniques that provide the necessary precision and accuracy. Recommended techniques include screw traps, fyke nets, and inclined plane traps. Seven consecutive year study periods are recommended to coincide with the study addressing MF Objective 6b and so marine survival can be evaluated for at least one brood year chum salmon and five brood years of pink salmon (see MF Objective 6).

6b) How many adult pink and chum salmon return to streams within and adjacent to areas potentially affected by the port facility and transportation/pipeline corridor?

Study Objective / Recommendation: Estimate the abundance of adult pink and chum salmon escapements to impact streams (Iniskin River, Knoll's Head Creek [aka Y-Valley Creek], Cottonwood Creek) nearby the port facility (including the transportation corridor along the coast), and in one or more reference areas (e.g., Bruin River, Ursus/Rocky coves). Assessment should occur over at least a seven consecutive year period before project initiation with

subsequent seven consecutive year study periods every 20 years throughout the duration of port operation to monitor for long-term accumulative impacts. Precision should be within 10% of the true value 95% of the time to ensure sufficient statistical power to detect changes in abundance trends between impact and reference streams.

Discussion and Justification: Abundance of adult anadromous species should be assessed using methods and techniques that provide the necessary precision and accuracy. Recommended techniques include M-R, weirs, counting towers, and sonar. Agencies do not consider aerial surveys as an adequate method for assessing adult fish abundance. Aerial survey methods do not provide the necessary precision and accuracy to assess potential impacts or to monitor for changes due to operation of the mine, transportation corridor, and port facility. Escapement results should be combined with commercial harvest data so total returns can be estimated for target species and streams. Seven consecutive year study periods are recommended so marine survival and spawner-recruit relationships can be determined for at least one brood year of chum salmon and five brood years of pink salmon (see MF Objective 6).

Shellfish and Groundfish (SG)

Studies are needed to determine the seasonal abundance and distribution of marine shellfish and groundfish species (e.g., Tanner, Dungeness and red king crab, scallops, flatfishes and rockfishes, etc.) in the area. These studies should also identify important areas (e.g. feeding, spawning, and overwintering habitats) for species that may be negatively impacted by the development and operation of the vessel approach corridor and port facility. Simultaneous seasonal collection of similar baseline data at nearby reference sites should help account for natural variability when future monitoring efforts are conducted to assess potential impacts associated with operation of the vessel approach corridor and port facility.

As there are numerous groundfish and shellfish species occurring in the area and their diets are varied with a number of species feeding at several or various trophic levels and on a wide range of prey sizes and types, an inventory of the benthic macro-, micro-, and meiofauna needs to be undertaken. Due to the selectivity of gear types, many sampling devices should be used to ensure that a practicable inventory of the diversity of prey organisms present is prepared. For

example, beach seines and bottom trawls are selective, capturing some species in a predictable manner and either missing others altogether (due to their body shape, elusive behavior, or swimming speed) or capturing them in an unpredictable manner. Therefore, gear types should be appropriate to ensure an accurate measure of species richness and a precise measure of relative abundance can be achieved. Since some species may be resident while others are transient or possess ontogenetic habitat preferences, sampling should be conducted in all oceanographic seasons. The temporal and spatial resolution of methods used for all recommended studies should be sufficient to detect intra- and inter- annual differences in impact and reference study sites. While all suggested surveys should be conducted at least four times per year to encompass temporal and oceanographic seasons, we recommend that the timing of one of each of the suggested surveys coincide with ADF&G surveys in the area (May/June) each year and use the same gear types (suggested herein).

All suggested research should be conducted over at least a five year period prior to the opening of Pebble Mine and its port facility, with a minimum of subsequent four year study periods every 10 years throughout the duration (lifetime) of mine and port facility operations to monitor for long-term, cumulative impacts. To that end, research should be repeated for a minimum of four year periods over every 10 years for a minimum of 50 years after mining and port operations cease.

1) **What is the relative abundance and biomass of shellfish species in deeper subtidal habitats within and adjacent to the potentially affected area(s)?**

Study Objective / Recommendation: Estimate the relative population abundance and biomass of shellfish species in deeper subtidal habitats within and adjacent to the proposed approach transportation corridor, specifically focusing on juvenile and adult male and female Tanner, Dungeness, red king crab, shrimp and octopus. All shellfish species caught should be documented to assist in completing a species inventory for the area. Population estimates for crab species should be by standard crab size class used in agency assessments to allow comparison with existing agency survey data. We suggest two approaches to addressing the abundance and biomass crab in the area. We suggest using a 400 eastern trawl (with a 78'headrope if possible to match Department gear) with 4" mesh at the net mouth followed by

3.5" mesh and a 1¼" liner in the cod end. We suggest the survey design randomly select a sufficient number of trawl stations within and adjacent to the vessel transportation corridor in order to test the null hypothesis that there is no statistically significant difference between crab abundance and biomass within the corridor and in the adjacent area to the corridor between pre-port facility and post-port facility operations. The analyses should make sure to include seasonal effects. We also strongly suggest that crab pot surveys be conducted for Tanner, Dungeness and red king crab using pots designed specifically for those species, but that have a mesh size no larger than ½" stretch mesh to ensure the capture of small crab as well as larger crab. For the pot surveys, we suggest randomly selecting a sufficient number of stations to sample within and adjacent to the vessel transportation corridor, and that crab pot surveys also be conducted at the following three reference areas: Chinitna Bay, Bruin Bay and either outer McNeil Cove or outer Akumwarvik Bay.

Discussion and Justification: It is essential that the relative abundance and biomass of these important shellfish species be known prior to the opening of the Mine and port facility. Simultaneous collection of similar baseline data at nearby reference sites must be done prior to and after port construction (and within and adjacent to the vessel approach corridor if dredging is to occur). This will enable natural variability to be accounted for when future monitoring efforts are conducted to assess potential impacts associated with construction and operation of the port facility and the vessel approach corridor.

2) What is the relative abundance and biomass of groundfish species in deeper subtidal habitats within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the relative population abundance and biomass of juvenile and adult groundfish species (e.g. flatfishes, Pacific cod) in deeper subtidal habitats within and adjacent to the proposed vessel approach corridor and port facility. All groundfish species caught should be documented to assist in completing a species inventory for the area. We suggest using a 400 eastern trawl (with a 78'headrope if possible to match Department gear), with 4" mesh at the net mouth followed by 3.5" mesh and a 1¼" liner in the cod end. We suggest the survey design randomly select a sufficient number of trawl stations within and adjacent to the vessel approach corridor in order to test the null hypothesis that there is no

statistically significant difference between groundfish abundance and biomass within the corridor and in the adjacent area to the corridor between pre-port facility and post-port facility operations. The analyses should make sure to include seasonal effects. In addition to abundance and biomass estimates, length and weight frequency distributions of groundfish species such as Pacific cod, pollock, sharks, skates, lingcod and all rockfishes should be produced. Weight, length and age data (ages from otoliths, fin rays, vertebrae or spines depending on species) should be taken in a manner consistent with agency assessments to allow comparison with existing agency survey data.

Discussion and Justification: It is essential that the relative abundance and biomass of these important groundfish species be known prior to the opening of the Mine and port facility. Simultaneous collection of similar baseline data at nearby reference sites must be done prior to and after port construction (and within and adjacent to the vessel approach corridor if dredging is to occur). This will enable natural variability to be accounted for when future monitoring efforts are conducted to assess potential impacts associated with construction and operation of the port facility and the vessel approach corridor.

3) What is the relative density of marine fishes and macroinvertebrates in intertidal and shallow subtidal habitats within and adjacent to the potentially affected area(s)?

Study Objective / Recommendation: Estimate the relative density of marine fishes (including juvenile stages) and macroinvertebrates (e.g. green urchins, red sea cucumber, commercial and non commercial crabs and shrimp, etc.) in intertidal and shallow subtidal habitats within and outside of the proposed port facility. Sampling sites outside of the port facility should extend as far as that which may be affected by an oil, chemical, or material spill.

Since timing of spawning and larval and juvenile settlement varies seasonally for the many groundfish that occur in the Kamishak Bay area, and ontogenetic shifts in habitat use may occur for some species, and since mining activities are proposed to occur year round, sampling should take place during in all seasons of the year.

We suggest the survey select a sufficient number of locations in order to test the null hypothesis that there is no statistically significant difference in the catch-per-unit-effort (between pre and post mining operations) between potentially affected sites at or immediately adjacent to the port facility and vessel approach corridor and reference locations in Kamishak Bay. Similar test should be performed using a species diversity index. We suggest the following three reference areas: Chinitna Bay, Bruin Bay and either outer McNeil Cove or outer Akumwarvik Bay. A balanced sampling design with sites representing the range of habitats within the affected area should occur throughout the sampling area (e.g. same number of habitats with replicates both inside and outside the port facility). Recommended sampling techniques include beach seines, drop nets, epibenthic sleds, and under water visual census methods using scuba and remotely operated vehicle.

Discussion and Justification: It is essential that the relative intertidal and subtidal zone density of these important groundfish species be known prior to the opening of the Mine and port facility. The intertidal and subtidal zones serve as critical habitat for many juvenile fishes. Simultaneous collection of similar baseline data at nearby reference sites must be done prior to and after port construction (and within and adjacent to the vessel approach corridor if dredging is to occur). This will enable natural variability to be accounted for when future monitoring efforts are conducted to assess potential impacts associated with construction and operation of the port facility and the vessel approach corridor.

4) What is the distribution and density of kelp and algae along the Kamishak Bay?

Study Objective / Recommendation: In conjunction with GMS Objectives 6 and 7, estimate the distribution and density of forest kelp, understory kelp and algae in areas along the coast of Kamishak Bay that are adjacent to the Mine's port facility, and within and outside of the proposed vessel approach corridor.

Discussion and Justification: Canopy and understory forming kelp and algae provide structurally complex habitats essential to select life stages of a variety of marine organisms. It is therefore essential to document their relative density prior to the opening of the Mine and port facility. Dredging activities, if conducted, may increase suspended sediments and decrease light

transmission in the water column, both of which can reduce the successful germination of gametophytes.

INSTREAM FLOW

Through the technical working group process, a list of target species to be included in the instream flow study was developed. In order to model the availability of habitat for these species as a function of stream flow, patterns of habitat utilization and the habitats utilized must be adequately characterized. Site-specific patterns of habitat utilization need to be surveyed for each life history stage and strategy of target species and over a full range of stream flows and seasons that surveys can practicably be made. In terms of space, the full lateral and longitudinal distributions of habitat should be considered, from small headwater streams to complex floodplains such as those along the middle and lower reaches of Upper Talarik Creek. At sites occupied by fish, direct measurements of ground and surface water hydraulics, substratum, proximity to shoreline and water temperature are important. For those parameters that will be used to model habitat availability as a function of stream flow, additional measurements will also be needed at sites unoccupied by the particular life stage of fish being considered. These measures are needed to show that the parameters used for modeling actually influence habitat selection. When modeling habitat availability as a function of stream flow, model predictions will only be as good as the information used as input for the models.

Transects where habitat will be modeled as a function of stream flow also need to be adequately placed to account for the full range of habitats in the project area and with respect to the spatial and temporal distributions of life stages and strategies of target fish species. For this reason, the instream flow study needs to be fully integrative with the fisheries studies to focus the modeling of habitat to areas that are utilized by fish. The distributions of certain life stages tend to be clumped; therefore, the application of flow-habitat modeling should be designed to represent these distributions. In order to model habitat availability as a function of stream flow for target species, flow-habitat transects need to be utilized by these species at the life history stage being modeled.

Another important component of the instream flow study is the off-channel habitat study. Lateral hydrologic connectivity with peripheral spawning and rearing habitats should be assessed in order to estimate how reductions in flow will affect the availability of habitat. Shallow shorelines of main channels, side channels, sloughs (spring channels) and floodplain ponds are very important to fish production and can be the first to be affected by reductions in stream flow. If reductions in stream flow affect the wetted perimeters of these habitats first, lateral hydrologic connectivity should drive flow-habitat assessments for the life history stages and strategies of species using these habitats.

1) What is the question?

Study Objective / Recommendation: Estimate the full distribution of habitat types within all habitat dimensions in all streams that will experience a 10% or greater reduction in flow as a result of this project.

Discussion and Justification: Habitat maps are needed to define and inventory habitats and evaluate whether surveys were structured to fully represent the full range of habitats. When considering instream flow needs, habitat use by fish needs to be surveyed within the full vertical, lateral and longitudinal dimensions of habitat. This includes consideration of habitat use within units of the riffle pool sequence (referred to as mesohabitats in the context of IFIM/PHABSIM), and the full lateral and longitudinal distributions of habitat. The lateral distribution of habitat includes main stream channels, side channels, floodplain ponds and spring channels. The longitudinal range of habitats includes the smallest of tributary streams, lakes and differences in channel planform (e.g. split-channel vs. single thread reaches) within each stream throughout the study area. Habitat maps are needed to assess whether or not habitat utilization has been adequately surveyed throughout the full range of these habitats. The common approach in IFIM/PHABSIM studies is to fully map habitats prior to field surveys as a basis for habitat suitability data collection so that modeling results will be sound and meaningful. Modifications to existing studies may be needed once this information is provided and reviewed.

Habitat maps are also needed to guide the placement of hydraulic modeling transects. Transects should be placed within the full range of habitats and allocated within each strata in proportion

with the commonness of each strata. The use of habitat, or the distributions of the life history stages and strategies of target species, also need to be considered and integrated into the transect selection process. In addition to representing the full range of habitats, transects should be placed at locations where particular life stages and strategies of target species are known to congregate. This is needed so that the full range of hydraulic conditions *that are important to fish* are represented. By placing transects on the sole basis of habitat types and their availability, we run the risk of misrepresenting or missing the full range of hydraulic conditions important to fish. Different life stages and strategies of target species can utilize a diverse and very different range of hydraulic conditions. The differences in hydraulic conditions between main channel and spring channel sockeye spawning strategies are a good example. Transects need to be placed in these different hydraulic environments so that full range of hydraulic conditions important for these species are represented.

2) What is the question?

Study Objective / Recommendation: Survey and document habitat use by target species in each of their life history stages, throughout the full distribution of habitats, over the seasonal range of stream flows and in all seasons as practicable.

Discussion and Justification: It is unknown whether or not habitat use surveys were conducted with regard to the full range of habitats and seasons of their usage. Surveys that are limited in space and time cannot fully represent patterns of habitat utilization and therefore cannot be used to develop habitat suitability criteria and predict the quality or quantity of habitat as a function of stream flow. Patterns of habitat use by fish in project streams differ by species life history stage, strategy and season. Whereas spawning may occur in headwater streams for some species (e.g. coho), rearing in the same species may occur in floodplain spring channels and ponds (e.g. coho).

3) What is the question?

Study Objective / Recommendation: Measure the habitat characteristics within those habitats utilized by each target species and life stage.

Discussion and Justification: In addition to surveying the full range of habitats and extending these surveys throughout all seasons, habitats that are utilized by target species must be fully characterized. In IFIM/PHABSIM specific sites used by fish are often referred to as micro-habitats, such as undercut banks, pool-tailouts, mid-channel bars. At sites occupied by fish, surface water and groundwater hydraulics, substratum, cover (instream and riparian cover), proximity to shoreline and water temperature need to be characterized. Surface water hydraulics include depth, velocity and interactive terms used to describe bulk flow characteristics (e.g. Froude number); groundwater hydraulics refer to the direction and magnitude of the vertical hydraulic gradient, or the direction and magnitude of ground and surface water exchange. The inclusion of vertical hydraulic gradient and intra-gravel/stream bed water temperature is essential since these parameters are thought to have a significant influence on the suitability of spawning and overwintering habitat.

4) What is the question?

Study Objective / Recommendation: For those parameters that will be used to model habitat availability as a function of stream flow, measure these characteristics at sites unoccupied by the particular life stage of fish being considered.

Discussion and Justification: This is necessary in order to assess which characteristics are influential to habitat selection. In order to assume that a particular physical parameter is influential to habitat selection it must be shown that it differs between occupied and unoccupied sites (micro-habitats). Such comparisons need to be made among similar habitats within the full distribution of habitats. For example, for those sockeye that spawn in main channel environments, the full list of habitat parameters must be assessed at sites with high spawning densities and at sites with little or no spawning to assess the relative importance of each habitat parameter and whether or not they are influential to redd site selection. Sockeye spawning in the upwelling reach of South Fork Koktuli provide a specific example. If the surface water hydraulics at spawning aggregations in the upwelling reach do not differ with the surface water hydraulics at sites with little to no utilization, this would suggest the importance of other habitat parameters that may or may not be incorporated into PHABSIM. The use of PHABSIM will only be appropriate for those species, life stages and life history strategies (e.g. main channel and

spring channel sockeye populations) for which the input variables used to model habitat area are the primary physical factors influencing habitat selection.

5) What is the question?

Study Objective / Recommendation: Measure and summarize habitat parameters such that their statistical significance can be evaluated.

Discussion and Justification: Only those habitat parameters that have a significant influence on habitat selection should be used to model habitat-flow relationships. This is needed to support the use of those habitat characteristics used to model instream flow needs and changes in habitat due to reductions in stream flow.

6) What is the question?

Study Objective / Recommendation: Characterize lateral hydrologic connectivity between stream flow in the project-affected streams and spring channels and ponds within the floodplains of these streams.

Discussion and Justification: It is assumed that there is a hydrologic connection between project-area streams and aquatic habitats embedded within the floodplains of these streams, yet the nature of these connections remains uncharacterized. Reductions in flow resulting from the development of this project could, therefore, reduce the quantity of water and wetted perimeter of floodplain water bodies hydrologically connected with stream flow in project streams. The nature and level of hydrologic connectivity must be characterized between stream flow in main channels, side channels, spring channels and ponds to estimate how reductions in stream flow will affect the wetted perimeter of interconnected floodplain water bodies.

Attachment A

Guidelines for Establishing Project Objectives
for Biological Fisheries Investigations

Contributed by:
Dr. David R. Bernard[3]

When developing a biological fishery investigation proposal, there are often two types of objectives: management applications and statistical. They can be one in the same, but more often are not. Management objectives are usually expressed as a question, such as "Is this chinook salmon harvest sustainable?" "Are we meeting our escapement objectives?" or "Is infection by *Ichthyophonus* detrimental to production?" The issues are implicitly management hypotheses (" Harvest is sustainable," "Desired escapement is maintained," or "*Ichthyophonus* impairs production") that can be rephrased to become scientific objectives ("To determine if harvest is sustainable," "To assess if desired escapement has been achieved," or "To determine if *Ichthyophonus* impairs production.") These management objectives are essential when judging the importance and relevance of the proposed work.

Statistical objectives concern evidence that would confirm or disconfirm a scientific hypothesis or explanation (confirm here means to increase the likelihood of being true). The evidence is in the form of estimates from sampling programs ("to estimate harvest"), from experiments ("to test the hypothesis that temperature increases mortality"), or from observational studies ("to test the hypothesis that infected fish suffer the same mortality rate as uninfected"). Statistical evidence must be relevant to the scientific hypothesis being tested and must be obtainable with the proposed methods and proposed levels of funding. For this reason, statistical objectives when feasible should be the centerpiece of detailed investigative plans, and these objectives should have statistical criteria.

[3] Dr. Bernard is Supervisor of Research and Technical Services, Sport Fish Division, Alaska Department of Fish and Game, and is a member of the Technical Review Committee.

Detailed investigation proposals should develop objectives specified in terms of estimates and tests and each with criteria for the following reasons:

1. Statistical criteria will allow fisheries managers to determine what they believe to be an acceptable risk of obtaining bad evidence.
2. Sample sizes are linked to statistical criteria; and
3. Funding is linked to sample sizes.

Having the project investigators describe in writing how they made these links will demonstrate that the problem or eventual application of the information has been thoroughly considered. In other words the investigator has considered how good an estimate or test needs to be to support their scientific hypothesis. They've calculated how intensively they need to sample or experiment to get such an estimate or test, and they have figured out how much money they will need to get the samples or run the experiment. In short, the detailed project proposal serves as evidence that project personnel are likely to successfully conclude the proposed project. Unfortunately, there has been a tendency not to require such rigor, especially statistical rigor, in plans by groups without access to statisticians, biometricians, or their advice. Collective experience of agencies with stock assessment, harvest monitoring, and surveys relative to fish populations and fisheries has shown that without this rigor the chance of failure greatly increased for these projects. Failure in this instance usually takes the form of gathering statistical evidence that is irrelevant to the scientific objective or, more often, obtaining statistical evidence that is too biased or imprecise to be useful. Management decisions made with this type of data are difficult to defend and more importantly may cause harm to the fishery resource or rural subsistence users who depend on the resource.

Establishing Statistically Sound Project Objectives. Objectives concern estimates and tests that "drive" the study through determination of sample sizes, experimental designs, and/or sampling designs. If sampling is involved in attaining an objective, objective statements begin with the infinitives "to estimate" or "to test." Other infinitives, such as "to assess," "to determine," "to measure," and "to evaluate" are ambiguous and have no statistical meaning. Objective criteria are attached to each objective statement. For example:

To estimate the ...(statistic)... such that the estimate is within d units (or d percent) of the actual ...(parameter)... (1-)x100 percent of the time.

To estimate the abundance of mature burbot in Lake Louise such that the estimate is within 10% of the actual abundance 95% percent of the time.

To test the hypothesis that ...such to detect at least a difference of d units between ...(treatment means)... with a and b probabilities of Type I and II errors, respectively.

To test the hypothesis that survival rates of coho salmon hooked and released in the estuary of the Little Susitna River are the same as those coho salmon hooked and released farther upstream such to detect at least a difference of 0.10 between survival rates with = 0.05 and = 0.10.

The quality of the desired estimate or test is specified through the objective criteria. These criteria and an a priori measure of variance and/or abundance obtained from a pilot study or from similar work will be used to set sample sizes. Specification of statistical criteria is of paramount importance; this is the means by which appropriate levels of sampling can be determined. Other ways to specify criteria are acceptable just so long as they are understandable and unambiguous.

If populations are censused (every member handled), objectives do not have statistical criteria because the sample size and the population size are implicitly the same.

To count the number of adult coho salmon entering Bear Lake to spawn.

Some estimates or tests will not drive sampling. For instance, catch in a sport fishery can be estimated for two species with a creel survey, but only the harvest of one species may be important to management. If harvest of the secondary species will be calculated, these items are listed as tasks in a separate paragraph in this section.

References:

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
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September 5, 2008

Michael F. Gearheard, Director
Office of Water and Watersheds
U.S. Environmental Protection Agency, Region 10
1200 Sixth Ave., OWW-130
Seattle, WA 98101

Dear Mr. Gearheard:

The National Marine Fisheries Service (NMFS) has provided expertise on the proposed Pebble Mine project since 2003. NMFS sees value in continued participation in such dialog, but we have grown increasingly concerned about whether our comments are being carefully considered by the Pebble Limited Partnership (PLP). We appreciate Environmental Protection Agency (EPA) participation to date and, in anticipation of EPA's role as lead federal regulatory agency for the project, we offer the following comments and request a follow-up discussion.

NMFS recognizes that the proposed project is in an exploratory phase and, while the full scope of the project has not been finalized, it has the potential to adversely impact resources of our concern. According to information submitted by Northern Dynasty Mines in 2006, the operation would be comprised of an open pit mine nearly two miles in diameter and up to 2000 feet deep and an underground mine of equal diameter and a depth of 5000 feet. Several large tailings impoundments encompassing up to 10 square miles are also proposed for mine waste. NMFS notes that the planned mine sites are located in proximity to vast hydrologically connected watersheds and tributary systems that support spawning and rearing habitat, as well as the migratory corridors essential to all salmonid species associated with the Bristol Bay region. NMFS is concerned that operations of the planned mine would result in the disruption of complex and connected hydrogeomorphic processes through the liberation of naturally occurring mineral and metal deposits and the latent release of mine tailings waste, which could adversely affect salmon and their habitat in these watersheds. This would likely have negative consequences for marine resources in Bristol Bay and associated commercial, recreational, and subsistence fisheries.

In the summer of 2007, at the request of PLP, state and federal resource agencies met with PLP representatives to develop an oversight Steering Committee and Technical Working Groups (TWG), both to consist of representatives of state and federal resource agencies. Facilitated by the Alaska Department of Natural Resources, the purpose for doing so was to assemble all related state and federal resource agency expertise *"to provide suggestions related to baseline studies for the Pebble Project, and help determine the scope of studies, geographical extent, methodologies and means to best coordinate study efforts."* NMFS' primary objective for participating in these meetings has been to ensure that PLP's environmental baseline studies are conducted in a manner that facilitates designing the Pebble Mine project in such a way that

minimizes impacts to NMFS' trust resources. NMFS further seeks to ensure that there is sufficient monitoring of changes in the environment, so that proactive steps can be taken to correct potential problems before they have an adverse affect on fish or their habitats.

Environmental studies associated with a project of this magnitude and potential impact must be of sufficient detail and design to withstand a high level of scientific scrutiny. Such studies should include: 1) clearly defined objectives; 2) supporting statistical design, including defined levels of precision and accuracy; 3) correlated sampling methods and effort; and 4) compilation and analysis of data to answer the objectives. For example, estimating the number of adult salmonids returning to and the number of salmonid smolt migrating out of these watersheds requires clear design methodologies and monitoring protocols to evaluate future effects with reasonable precision. This level of rigorous design would allow the monitoring of fish population trends and distinguish the effects of this mining operation against natural variability and other large scale anthropogenic effects, such as commercial or subsistence fishing. Such studies and monitoring protocols are particularly important given the many examples of negative effects that hard rock mining has had on aquatic ecosystems worldwide, including effects on anadromous fish populations and habitat within the Pacific Northwest.

Within the TWG process, NMFS has repeatedly expressed concern that PLP's baseline study designs are inadequate and that associated results will not represent an accurate assessment of the impacts of the mine's operations on the area's resources. NMFS is aware that the PLP has conducted fisheries related studies for four years (2004-present), yet has released little detail regarding specific study designs, methods, or results to the TWGs. The Steering Committee and associated TWGs provide an excellent opportunity for PLP to work cooperatively with resource agencies to further develop, design, and implement scientifically defensible studies. However, despite suggestions by NMFS for more rigorous and robust study designs to monitor for future effects and/or suggestions to employ less expensive, more applicable and accurate methods, PLP has not demonstrated that these suggestions have been incorporated into any study design. Without detailed information from PLP, NMFS cannot confirm that ongoing or planned studies will be adequate for analyzing potential impacts to fish and fish habitat.

We look forward to discussing our concerns with you in more detail and would be interested in exploring ways that NMFS can work more closely with the EPA and others to resolve these outstanding issues and concerns. In this regard, NMFS would be willing to facilitate convening key agencies for such a discussion. As a part of this, we would like to discuss how EPA foresees the State of Alaska assuming primacy of the National Pollutant and Discharge Elimination System permits and how this could affect the Pebble Mine permitting process and the structure and function of the Steering Committee and TWGs.

Please contact my staff, Jeanne Hanson at (907) 271-3029, or Nicole LeBoeuf at (907) 586-7122, to arrange a time to discuss further.

Sincerely,

Robert D. Mecum
Acting Administrator, Alaska Region

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G: EPA/Mining Pebble Mine nl jh 9-5-08

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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September 1, 2004

Ms. Ella Ede
Northern Dynasty Mines Inc.
3201 C Street, Suite 604
Anchorage, Alaska 99503

Re: Pebble Gold Copper Project

Dear Ms. Ede:

The National Marine Fisheries Service (NMFS) has reviewed the Pebble Gold Copper Project Draft Environmental Baseline Studies Plan for 2004, dated July 2, 2004. The project proponent is Northern Dynasty Mines Inc. (Northern Dynasty). The proposed project involves open pit mining operations for gold, copper, molybdenum, and silver deposits in the Iliamna Lake, Upper Talarik and North Fork Koktuli drainages in southwestern Alaska. The estimated milling capacity for the Pebble Project ranges from 90,000 to 200,000 tons per day, and the estimated mine life ranges from 30 to 60 years. Mine operations include mining, tailings disposal, ore and waste rock hauling (road construction), shipping (port construction west side of Lower Cook Inlet), and eventual reclamation.

The Draft Environmental Baseline Studies Plan offers an adequate description of proposed mining related environmental issues that may potentially affect our trust resources. However, the studies are fairly general and NMFS' concerns are twofold. First, we are concerned about the spatial scale of the proposed studies; impacts to fisheries resources and essential fish habitat (EFH) could easily extend beyond the project boundaries. NMFS recommends that you extend the scope of baseline studies to include both downstream and upstream areas that could be affected by mine operations. Those studies should include mining, tailings disposal, ore and waste rock hauling, shipping, and eventual reclamation. The primary purpose of studies should be to establish a sufficient baseline, along with a monitoring/temporal component to the study design, and to assess changes in the environment over time resulting from all project components.

Second, NMFS concurs with the National Park Service comments that given the large variability that is typical of natural systems, the fish and water quality studies as described are likely to be insufficient to detect potential changes due to the proposed mine. The before-after-control-impact (BACI) study design (Skalski and McKenzie 1982) with replicates of each type has been used with success in environmental impact studies (Day et al. 1997, Irons et al. 2000). The current study plan includes no similar unimpacted sites (controls) for comparison and minimal pre-impact data. With only "after-impact" information, and little "before-control" data, Northern Dynasty will have a difficult time deciding if an observed change was due to: 1) the impact (mining, road, port...etc.), 2) an unrelated factor, or 3) natural variability of the response.

NMFS recommends Northern Dynasty schedule an interagency coordination meeting including representatives from State and Federal agencies as well as local governments. Project sponsors should describe the proposed project (including mining, tailings disposal, road, port, and power options) and the proposed schedule in as much detail as possible. Existing information for each of the major study areas and any results of 2004 field studies should be provided and discussed. An interagency field visit following the meeting and prior to winter would valuable.

NMFS appreciates your early coordination and hopes this information is useful. Brian Lance (907) 271-1301 is the NMFS contact for this project.

Sincerely,

James W. Balsiger
Administrator, Alaska Region

cc: USFWS, EPA, ADGC, ADFG, ADNR/OHMP, ADEC, NPS – Anchorage

References:

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